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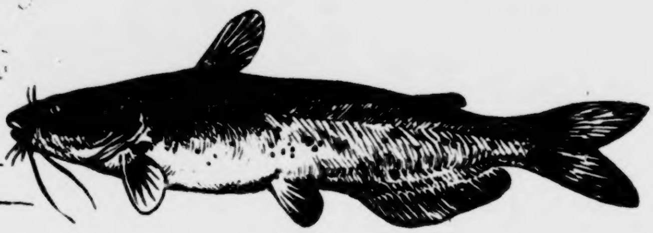

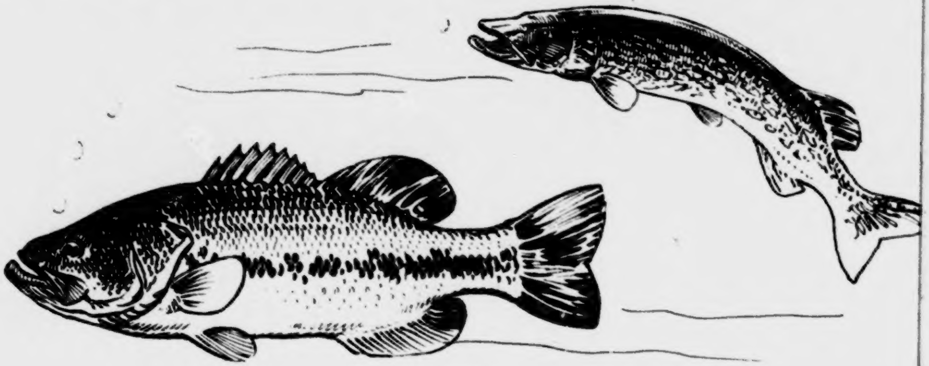

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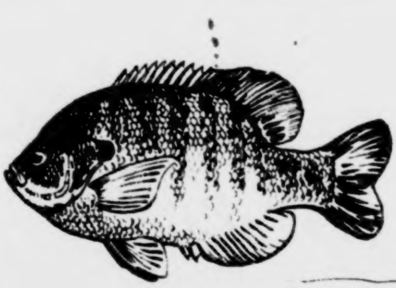

US Fish and Wildlife Service

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August 1982

# FISH CULTURE

# AN ANNOTATED BIBLIOGRAPHY OF PUBLICATIONS OF THE NATIONAL FISHERIES CENTER - LEETOWN

## 1972 - 1980

by

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# INTRODUCTION

This is an annotated bibiliography of the publications authored or co-authored by the staff of the National Fisheries Center - Leetown (NFC-L) from 1972 through 1980. It includes publications from NFC-L staff at the Fish Farming Experimental Station, Stuttgart, AR; the Fish Genetics Laboratory, Beulah, WY; the Hagerman Field Station of the Tunison Laboratory of Fish Nutrition, Hagerman, ID; the National Fisheries Research and Development Laboratory, Wellsboro, PA; the Southeastern Fish Cultural Laboratory, Marion, AL; and, the Tunison Laboratory of Fish Nutrition, Cortland, NY. It also includes publications from NFC-L staff at the Aquaculture Production/Demonstration Station, Fisheries Academy, Fish Genetics Station, National Fish Health Research Laboratory, and Technical Information Services, each located in Kearneysville, WV. Prior to 1977, each functioned as a separate entity within the U.S. Fish and Wildlife Service. In 1977, the administrative and program activities of these components were merged into the National Fisheries Center. This bibliography lists the publications issued by each of these entities both before and after becoming joined into the Center. Publications from these components prior to 1972 are documented in U.S. Bureau of Sport Fisheries and Wildlife, Resource Publication 120, *Bibliography of Research Publications of the U.S. Bureau of Sport Fisheries and Wildlife, 1928-72.*

Entries in this bibliography are arranged under broad subject categories, similar to those used in U.S. Fish and Wildlife Service, *Sport Fishery Abstracts*. Within these categories, the publications are then arranged alphabetically by author and sequentially by date of publication. They cover a wide range of scientific and technical disciplines applicable to the field of aquaculture. The annotations were submitted by each NFC-L component, and were modified to some extent for uniformity. An author index is included at the end of the bibliography.

To obtain any of the references listed herein, readers are encouraged to first contact their local libraries. When library assistance is unavailable, or if the reference proves difficult to obtain, the Technical Information Services of the National Fisheries Center will provide xerox copies on request. The address is Technical Information Services, National Fisheries Center - Leetown, Box 700, Kearneysville, WV 25430.

I wish to thank those persons from each component who cooperated so fully and gave so much of their time to this effort.

JOYCE A. MANN

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## AQUATIC PLANTS AND THEIR CONTROL

Martin, M.
1980. You asked for it! What label may not tell you about aquatic herbicides. Aquaculture Magazine 6(3):43-45.

Information concerning the use of labeled aquatic herbicides for treating algae, submerged rooted weeds, emergent weeds and ditch bank weeds.

Newton, S. H., J. M. Martin, J. N. Ferguson, and D. L. Gray.
1979. Grass carp aid removal of weeds in irrigation canals and reservoirs. Arkansas Farm Research 28(4):12.

Effects of grass carp on reducing pumping and irrigation problems in Arkansas canals and reservoirs over an eight-year period.

Stanley, J., and K. Sneed.
1973. Scope of Corps of Engineers cooperative research aquatic plant control program: white amur studies. Appendix B in Herbivorous fish for aquatic plant control. U.S. Army Engineers Aquatic Plant Control Program, Technical Report 4. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

A short outlined discussion on artificial gynogenetic reproduction of white amur (*Ctenopharyngodon idella*) and its significance in an aquatic vegetation control program. Contains an experimental design for laboratory and field studies of the species.

## GENERAL FISH CULTURE

Bailey, W. M., F. P. Meyer, J. M. Martin, and D. L. Gray.
1974. Farm fish production in Arkansas during 1972. Pages 750-758 in Proceedings of the Twenty-seventh Annual Conference Southeastern Association of Game and Fish Commissioners, Hot Springs, Arkansas. 14-17 October 1973.

Fish farming production returns exceed $21 million in 1973. Acreage, production and dollar values are given for food fish, bait fish, fingerlings and fee fishing.

## GENERAL FISH CULTURE (CONTINUED)

Bailey, W. M., M. D. Gibson, S. H. Newton, J. M. Martin, and D. L. Gray.
1978. Status of commercial aquaculture in Arkansas in 1975. Pages 246-250 in Proceedings of the Thirtieth Annual Conference Southeastern Association of Fish and Wildlife Agencies, Jackson, Mississippi. 24-27 October 1976.

The results of a telephone and personal survey of all known Arkansas fish producers in 1975. The value of aquaculture to the farmers was $24,191,700.

Dupree, H. K.
1978. You asked for it! Late winter planning increases the efficiency of labor scarce fish producer. Commercial Fish Farmer and Aquaculture News 4(3):42-43.

Some suggestions for "slack" time planning to increase efficiency the following season.

Giudice, J.
1975. You asked for it! Answers to questions about fish farming. Commercial Fish Farmer and Aquaculture News 1(5):38-39.

Answers to questions from fish farmers, e.g., How many shrimp can be produced per acre and what are some problems involved in shrimp culture? What stocking density should I use for newly-hatched fingerlings in ponds? Would it be feasible to enclose an area for catfish farming on a large natural lake where catfish are caught commercially by trotline? Why would catfish nests seem to disintegrate in my hatchery at the height of spawning? What size catfish are preferred by the fee fishing industry?

Giudice, J.
1975. You asked for it! Answers to questions about fish farming. Commercial Fish Farmer and Aquaculture News 1(6):39.

Answers to questions from fish farmers, e.g., What is the best method for separating shiners from channel catfish grown in the same pond? Is there a way to kill black perch and bream without killing my minnows? Is there a parasite in the ovary of shiners which prevents them from spawning? What method of control would you suggest for brush along the levees of fish ponds? Is feeding completely around the pond worth the extra time involved? What can I feed baby goldfish?

## GENERAL FISH CULTURE (CONTINUED)

Guidice, J.
1975. You asked for it! Answers to questions about fish farming. Commercial Fish Farmer and Aquaculture News 2(2):51.

Answers to questions from fish farmers, e.g., should I feed expensive fish foods to tilapia? How is pompano raised commercially? Can I raise channel catfish, crayfish, and goldfish together? How complete is a diet of ground corn, liver, or spleen for channel catfish? What problems are there in raising fish in the Colorado Rockies?

Giudice, J. J.
1976. The baitfish industry. Pages 121-127 in Proceedings of the 1976 Fish Farming Conference and Annual Convention Catfish Farmers of Texas, Texas A&M University, College Station, Texas. 20-21 July 1976.

Marketing technology remains the most important aspect for the potential baitfish producer to consider. Factors to be considered are market potential and locale, the market level best suited to the individual, species of baitfish to meet market demand, and the culture method that will coincide with other enterprises.

Giudice, J. J.
1976. You asked for it! Everything will FALL in place with good management practices. Commercial Fish Farmer and Aquaculture News 2(6):38-39.

Ten suggestions for the autumn months. Includes answers to questions from fish farmers, e.g., What is the most economical control chemical for algae and Chara in ponds? Can shiner brooders be combined in fewer ponds to conserve space? Is there a treatment for leaky ponds? Can tropical fish be raised in a catfish hatchery building during the off-season?

Giudice, J.
1979. Fish farming line. Aquaculture Magazine 5(6):29.

Report on current research, drugs, and other news for the fish farmer.

Giudice, J.
1979. Fish farming line. Commercial Fish Farmer and Aquaculture News 5(5):33.

Report on heat-treated full-fat soybean meal, nitrites as the causative agent in brown-blood phenomenon, and other news for the fish farmer.

## GENERAL FISH CULTURE (CONTINUED)

Gonzales, F. R., and M. Martin.
1975. Fish farming in the Philippines; an overview. Aquaculture and the Fish Farmer 2(2):4-5.

An interview with Felix R. Gonzales, Director of the Bureau of Fisheries and Aquatic Resources, Republic of the Philippines. It gives present Philippine acreages and production statistics, and presents plans for the future development of aquaculture in that country.

Martin, M.
1975. You asked for it! Answers to questions about fish farming. Commercial Fish Farmer and Aquaculture News 2(1):35.

Answers to questions from fish farmers. Can shrimp be grown in Texas? Can walleye be grown commercially?

Martin M.
1975. You asked for it! Answers to questions from persons interested in fish farming. Commercial Fish Farmer and Aquaculture News 1(4):51.

Answers to questions from fish farmers, e.g., Where can I get information on farming eels, salmon, lobster, crabs and frogs? What is the most economical way to make a sandy pond hold water? Can you recommend a comprehensive book on pond environment?

Martin, M.
1976. You asked for it! Fish farming in the cold country. Commercial Fish Farmer and Aquaculture News 2(4):38-39.

Answers to questions from fish farmers about fish farming in cold climates, e.g., What can you tell me about fish farming in Wisconsin? Do you have information on raising freshwater prawns or lake perch in a highly controlled environment? Can you provide information on raising bait fish in colder climates?

Martin, M.
1976. You asked for it! "Summertimely" tips for fish farmers. Commercial Fish Farmer and Aquaculture News 2(5):38-39.

Summer months can be a dangerous period in fish production. The good manager will be vigilant for conditions that cause trouble. Nine summer tips are included. Also there are answers to questions from fish farmers on the red shiner and on marshland ponds.

## GENERAL FISH CULTURE (CONTINUED)

Martin, M.
1976. You asked for it! Timely tips on fish farming techniques. Commercial Fish Farmer and Aquaculture News 2(3):44.

Thirteen pieces of advice on shiners and seventeen pieces on catfish. Includes answers to questions from fish farmers, e.g., Where can I find information on abalone and oyster culture? What can we do about ammonia buildup in a closed raceway system?

Martin, M.
1977. You asked for it! Worried about parasites while ponds have ice cover? Here are some ideas. Commercial Fish Farmer and Aquaculture News 3(2):40.

A method for treating an ice covered pond in which fish are heavily parasitized. Suggestions are given for winter feeding, levee maintenance, and reservoir fish culture. There is also an update on fish flour.

Martin, M.
1977. You asked for it! Your fish farming success for the year can depend upon management in the spring. Commercial Fish Farmer and Aquaculture News 3(4):40.

On the premise that the whole year's success in fish farming depends on what is done in the spring, the author offers some spring-time advice.

Martin, M.
1978. You asked for it! Aquaculture failures can be avoided. Commercial Fish Farmer and Aquaculture News 5(1):55-56.

Article devoted to the pitfalls encountered in aquaculture, e.g., raising fish geographically unsuited to an area, raising carnivorous species of fishes which often eat each other and for which live food is difficult and expensive to obtain, poor raceway design. It cites the federal regulations regarding aquaculture as farming, and lists a pitfall for the nation, i.e., the continual removal and eroding of nutrients from the soil.

## GENERAL FISH CULTURE (CONTINUED)

Martin, M.
1978. You asked for it! Despite major problems, the long-term future of fish farming appears bright. Commercial Fish Farmer and Aquaculture News 4(2):38-41.

Discusses factors which are almost certain to cause a growth in all aspects of fish farming -- factors such as the increased per capita consumption of fish, increased population, huge fish imports, stable or declining ocean fish stocks, use of fish in diets, and a trend toward a shorter work week. Also discusses constraints to growth of the industry.

Martin, M.
1979. You asked for it! Commercial Fish Farmer and Aquaculture News 5(5):24-27.

A summary of the state-of-the-art in fish row-crop rotation. Includes citations of pertinent literature.

## TROUT AND SALMON CULTURE

Brauhn, J. L., R. C. Simon, and W. R. Bridges.
1976. Rainbow trout growth in circular tanks: consequences of different loading densities. U.S. Fish and Wildlife Service, Technical Paper 86. 16 pages.

Prediction equations correlate density of fingerling rainbow trout with growth, yield, and food-use efficiency. These predictable density-dependent responses give fish-culturists alternatives of density selection to attain rapid growth, maximum weight gain, yield balanced with cost, and optimal fish quality.

Kincaid, H. L., W. R. Bridges, A. E. Thomas, and M. J. Donahoo.
1976. Rearing capacity of circular containers of different sizes for fry and fingerling rainbow trout. Progressive Fish-Culturist 38(1):11-17.

Rearing capacity studies to determine optimum loading densities in three sizes of circular containers for rainbow trout fry and fingerlings. Includes a discussion of density in relation to tank volume and in-flow rate.

## TROUT AND SALMON CULTURE (CONTINUED)

Leon, K. A.
1974. Growth and survival of Atlantic salmon (*Salmo salar*) reared in a plastic substrate. Pages 95-98 in Proceedings of the Third Fish Feed and Nutrition Workshop, Tunison Laboratory of Fish Nutrition, Cortland, New York. 24-25 September 1974.

A study to determine whether a plastic substrate would improve growth and survival of Atlantic salmon incubated and reared in a hatchery.

Leon, K. A.
1975. Improved growth and survival of juvenile Atlantic salmon (*Salmo salar*) hatched in drums packed with a labyrinthine plastic substrate. Progressive Fish-Culturist 37(3):158-163.

Reports the effects on growth and survival of incubating and rearing juvenile Atlantic salmon with and without a plastic saddle-shaped substrate.

Leon, K. A., and W. A. Bonney.
1979. Atlantic salmon embryos and fry: effects of various incubation and rearing methods on hatchery survival and growth. Progressive Fish-Culturist 41(1):20-25.

Compares the effects of conventional smooth-bottom incubation and rearing units with those containing various matrix substrates in specially constructed drums.

Thomas, A. E.
1975. Effect of egg concentration in an incubation channel on survival of chinook salmon fry. Transactions of the American Fisheries Society 104(2):335-337.

Compares survival rates of migrant chinook salmon fry after the eggs were stocked at different concentrations in an incubation channel. The difference in survival is not statistically significant.

Thomas, A. E.
1975. Effect of egg development at planting on chinook salmon survival. Progressive Fish-Culturist 37(4):231-233.

Results of tests in which chinook salmon eggs, in all stages of development, were evaluated for survival in incubation channels.

## TROUT AND SALMON CULTURE (CONTINUED)

Thomas, A. E.
1975. Evaluation of the return of adult chinook salmon to the Abernathy incubation channel. Fishery Bulletin 73(2):356-359.

Comparison of returns and potential egg production of adult chinook salmon in relation to original numbers from which they were produced.

## WARMWATER CULTURE

Allen, K. O.
1973. Effect of overhead cover on growth and survival of channel catfish in circular tanks. Progressive Fish-Culturist 35(4):213.

No significant differences are observed in growth, feed conversion or survival of channel catfish exposed to varying amounts of light. Some behavioral differences are noted.

Allen, K. O.
1974. Effects of stocking density and water exchange rate on growth and survival of channel catfish *Ictalurus punctatus* (Rafinesque) in circular tanks. Aquaculture 4(1):29-39.

An increase in stocking density results in an appreciable increase in net yield up to 360 fish/m$^3$, but mean fish weight, feed conversion efficiency and survival decreases with increasing fish density. Faster water exchanges benefit high stocking densities but appear to be of no advantage at intermediate or low stocking densities.

Allen, K. O.
1974. Raceway production: four costs that can make or break you. Fish Farming Industries 5(3):23-25.

An economic analysis of four factors, pumping, labor, feed, and stocking densities, that affect monetary returns from culturing channel catfish in circular tanks.

Allen, K. O., and R. R. Carter.
1976. Polyculture of channel catfish, tilapia, and hybrid buffalo in divided raceways. Progressive Fish-Culturist 38(4):188-191.

An evaluation of survival, growth, and feed conversion of three species of fish reared in a divided raceway system.

## WARMWATER CULTURE (CONTINUED)

Broussard, M. C., Jr., N. C. Parker, and B. A. Simco.
1974. Culture of channel catfish in a high flow recirculating system. Pages 745-750 in A. L. Mitchell, editor. Proceedings of the Twenty-seventh Annual Conference Southeastern Association of Game and Fish Commissioners, Hot Springs, Arkansas. 14-17 October 1973.

Effects of high flow rate and high filter to tank ratio on the carrying capacity of a recirculating system for channel catfish culture. Updraft and trickling filters with various filter media are evaluated.

Carter, R. R., and K. O. Allen.
1976. Effects of flow rate and aeration on survival and growth of channel catfish in circular tanks. Progressive Fish-Culturist 38(4):204-206.

Evaluates the effects of water turnover rates and various dissolved oxygen levels on channel catfish production. There are three tables comparing resulting data.

Carter, R. R., and A. E. Thomas.
1977. Spawning of channel catfish in tanks. Progressive Fish-Culturist 39(1):13.

A short note discussing a method used for controlled channel catfish spawning.

Dupree, H. K.
1979. You asked for it! A summary: warmwater fish culture course. Commercial Fish Farmer and Aquaculture News 5(3):35-36.

A report of the Warmwater Fish Culture Course, presented January 22-26, 1979 at the new Game and Fish Building in Little Rock, Arkansas. The course, co-sponsored by the Fish Farming Experimental Station, Stuttgart, Arkansas and the Fisheries Academy, Kearneysville, West Virginia, both U.S. Fish and Wildlife Service organizations, is designed to inform the fish producers of the current state-of-the-art of warmwater fish husbandry.

Giudice, J.
1974. You asked for it! Answers to questions from persons interested in fish farming. Commercial Fish Farmer and Aquaculture News 1(2):46-47.

Answers to questions from fish farmers, e.g., Is commercial production of channel catfish feasible in a pond that has an undesirable stunted population of scale fish? Is fertilizer required to produce a crop of catfish? Why do my fish stop feeding at times?

## WARMWATER CULTURE (CONTINUED)

Giudice, J.
1975. You asked for it! Answers to questions from persons interested in fish farming. Commercial Fish Farmer and Aquaculture News 1(3):38.

Answers to questions from fish farmers, e.g., Why raise tilapia or white amur since there is little or no market value for them? After harvesting, is there anything to be done before the spawning season begins? What is the reason for the increased production of buffalo? Why do growers continue to use ponds rather than raceways? Is there anything to be done with empty ponds before restocking them?

Green, O. L.
1972. Fingerlings to food fish. Pages 3-5 in J. G. Dillard, editor. Proceedings of the Missouri Catfish Conference, Lake Ozark, Missouri. 10-11 March 1970. University of Missouri, Columbia, Missouri.

Cultural methods and techniques for stocking, feeding, and harvesting channel catfish in ponds or troughs.

Green, O. L.
1973. Comparison of production and survival of channel catfish stocked alone and in combination with blue and white catfish. Progressive Fish-Culturist 35(4):225-226.

Data are provided in tabular form on the results of stocking channel catfish alone and in three different combinations with blue and white catfish.

Martin, J. M.
1976. Culture methods for raising forage fishes. Pages 33-45 in Proceedings of the 1976 Fish Farming Conference and Annual Convention Catfish Farmers of Texas, Texas A&M University, College Station, Texas. 20-21 July 1976.

Describes the desirable characteristics of forage fish, recent research break throughs, some species which may be cultured, and methods for obtaining good fry survival.

## WARMWATER CULTURE (CONTINUED)

Martin, M.
1977. You asked for it! Tips on how to increase fish farming profits. Commercial Fish Farmer and Aquaculture News 3(5):34.

Advice to warmwater fish farmers who are raising catfish or minnows as their main money crops.

Meyer, F. P., K. E. Sneed, and P. T. Eschmeyer, editors.
1973. Second report to the fish farmers. The status of warmwater fish farming and progress in fish farming research. U.S. Fish and Wildlife Service, Resource Publication 113. 123 pages.

The status of aquaculture in 1973. Includes research information on the production and farming of food fish, baitfish, sport fish and crawfish.

Parker, N. C., and B. A. Simco.
1974. Evaluation of recirculating systems for the culture of channel catfish. Pages 474-487 in A. L. Mitchell, editor. Proceedings of the Twenty-seventh Annual Conference Southeastern Association of Game and Fish Commissioners, Hot Springs, Arkansas. 14-17 October 1973.

Analysis of various flow rates, exchange rates, and tank to filter ratios in ten recirculating systems employing biological filters, settling chambers, and foam strippers. An equation is developed to evaluate the effects of system design on water quality.

Parker, N. C.
1979. Channel catfish production in continuously aerated ponds. Pages 39-52 in Proceedings of the 1979 Fish Farming Conference and Annual Convention Catfish Farmers of Texas, Texas A&M University, College Station, Texas. 17-19 January 1979.

Evaluation of continuously operated air-lift pumps as a method for increasing dissolved oxygen, preventing stratification, and increasing catfish production.

WARMWATER CULTURE (CONTINUED)

Sneed, K. E.
1972. Aquacultural water quality criteria. Pages 17-19 in Proceedings of the Catfish Production and Management Conference, sponsored by the Cooperative Extension Service, Veterinary Medicine College, State Natural History Survey, and Division of University Extension, University of Illinois of Urbana-Champaign, Illinois. 16-17 June 1972.

Discusses the effects of water quality on the commercial production of channel catfish.

Tackett, D. L.
1974. Yield of channel catfish and composition of effluents from shallow-water raceways. Progressive Fish-Culturist 36(1):46-48.

Stocking size and density influence fish yield in shallow-water raceways just as they do in ponds. The shallow water, with its inherent turbulence and velocity, prevents ammonia-nitrogen and dissolved oxygen from changing appreciably, assists in removal of BOD, and prevents a greater accumulation of solids.

Tackett, D. L.
1978. You asked for it! Water conservation, reuse and use. Commercial Fish Farmer and Aquaculture News 4(6):48-49.

Useful information on the cost, construction, and use of biological tube filters in channel catfish production.

Thomas, A. E.
1977. Production and survival of monosex grass carp in ponds. Page 24 in Proceedings of the Sixth Inland Commercial Fisheries Workshop, North Little Rock, Arkansas. 22-24 February 1977.

Review of monosex grass carp production at the Fish Farming Experimental Station, Stuttgart, Arkansas in 1975.

Thomas, A. E., and R. R. Carter.
1977. Survival of monosex grass carp in small ponds. Progressive Fish-Culturist 39(4):184.

A discussion on management practices used to rear grass carp, and their survival.

## WARMWATER CULTURE (CONTINUED)

Thomas, A. E., R. R. Carter, and D. C. Greenland.
1979. Survival of one- and two-year-old monosex grass carp in small ponds. Progressive Fish-Culturist 41(1):38.

A follow-up note to the article by Thomas and Carter, 1977.

U.S. Fish and Wildlife Service, Stuttgart, Arkansas.
1972. Factors affecting the growth and production of channel catfish in raceways. Technical Assistance Project No. 14-16-0008-571. U.S. National Marine Fisheries Service, St. Petersburg, Florida. 98 pages.

A broad spectrum work which includes studies in tanks (indoor and outdoor), raceways (including dirt raceways), cages; electrophoretic studies of plasma proteins, tissue composition of catfish, and a histologic study of liver of channel catfish.

## OTHER ANADROMOUS SPECIES

Allen, K. O.
1974. Notes on the culture of striped bass in tanks and small raceways. Progressive Fish-Culturist 36(1):60-61.

Management techniques for rearing striped bass in tanks and raceways.

Parker, N. C.
1980. Striped bass culture in continuously aerated ponds. Pages 353-360 in R. W. Dimmick, J. D. Hair, and J. Grover, editors. Proceedings of the Thirty-third Annual Conference Southeastern Association Fish and Wildlife Agencies, Hot Springs, Arkansas. 21-24 October 1979.

Determines production rates of striped bass fingerlings cultured in aerated ponds heavily fertilized with hay. The average number of fingerlings produced per hectare was 2.4 times greater than that normally achieved in conventional pond culture.

## FEEDS, FEEDING, AND NUTRITION

Beck, A. D., and H. A. Poston.
1980. Effects of diet on survival and growth of the Atlantic silverside. Progressive Fish-Culturist 42(3):138-143.

Compares results of feeding the marine Atlantic silverside various live and prepared diets. In both postlarval and juvenile silversides, growth rate and survival is greatest on a live diet of brine shrimp nauplii; it is lowest in fish fed the artificial diets.

Bengtson, D. A., A. D. Beck, and H. A. Poston.
1978. Comparative effects of live and artificial diets on growth and survival of juvenile Atlantic silverside, *Menidia menidia*. Pages 159-173 in J. W. Avault, Jr., editor. Proceedings of the Ninth Annual Meeting of the World Mariculture Society, Atlanta, Georgia. 3-6 January 1978.

Compares results of feeding prepared and live diets to the young Atlantic silverside. Growth and survival are best on a live diet of brine shrimp nauplii, but only slightly less on a combination artificial/live diet, demonstrating that partial nutritional requirements can be derived from an artificial food source.

Brandt, T. M., C. W. Deyoe, and P. A. Seib.
1978. Alternative sources of Vitamin C for channel catfish. Contribution No. 78-189-J. Department of Grain, Science and Industry, Kansas Agricultural Experiment Station, Manhattan, Kansas. 14 pages.

A comparison of ascorbic acid and three other ascorbate formulations in feeds for catfish. All test equally.

Brandt, T. M.
1979. Use of heat treated full-fat soybeans in channel catfish and golden shiner feeds. Pages 53-61 in Proceedings of the 1979 Fish Farming Conference and Annual Convention Catfish Farmers of Texas, Texas A & M University, College Station, Texas. 17-19 January 1979.

Full-fat cooked soybeans appear to be a suitable replacement for fish meal in channel catfish and golden shiner diets.

## FEEDS, FEEDING, AND NUTRITION (CONTINUED)

Davis, E. M., G. L. Rumsey, and J. G. Nickum.
1976. Egg-processing wastes as a replacement protein source in salmonid diets. Progressive Fish-Culturist 38(1):20-22.

A comparison of salmonid diets containing fish meal protein as the primary protein source and diets in which 50% of the fish meal protein is replaced by waste materials from processing dried eggs. Growth rates and feed conversion efficiencies of fish fed the replacement diet were as good as, or slightly better than, those of fish fed the fish meal diet.

Davis, K. B., N. C. Parker, and P. Torrance.
1980. Growth, body composition and liver tyrosine aminotransferase in the diet. In Abstracts of the Annual Meeting of the American Society of Zoologists, Seattle, Washington. 27-30 December 1980. American Zoologist 20(4):833. (Abstract 581).

Long-term cortisol administration can reduce growth and the condition factor of channel catfish by gluconeogenic activity on fat stores and amino acid degradation.

Dupree, H. K.
1976. Some practical feeding and management techniques for fish farmers. Pages 77-83 in Proceedings of the 1976 Fish Farming Conference and Annual Convention Catfish Farmers of Texas, Texas A & M University, College Station, Texas. 20-21 July 1976.

Practical advice to the fish farmer who is hindered in many areas by the limited availability of good-quality feeds formulated for fry, fingerlings, food-sized fish, and brood fish.

Dupree, H. K.
1976. Studies on nutrition and feeds of warmwater fishes. Pages 65-84 in K. S. Price, Jr., W. N. Shaw, and K. S. Danberg, editors. Proceedings of the First International Conference on Aquaculture Nutrition, Lewes/Rehoboth, Delaware. 14-15 October 1975. Sponsored by the Delaware Sea Grant College Program in cooperation with the U.S./Japan Aquaculture Panel. College of Marine Studies, University of Delaware, Newark, Delaware.

A detailed literature review on the nutritional requirements of warmwater fishes.

## FEEDS, FEEDING, AND NUTRITION (CONTINUED)

Dupree, H. K.
1977. Vitamin requirements. Pages 26-29 in R. R. Stickney and R. T. Lovell, editors. Nutrition and feeding of channel catfish; a report from the Nutrition Subcommittee of Regional Research Project S-83. Southern Cooperative Series Bulletin 218. Alabama Agricultural Experiment Station, Auburn University, Auburn, Alabama.

Discusses the role of and requirements for vitamins in finished feeds for catfish.

Dupree, H. K., E. J. Guaglitz, Jr., A. S. Hall, and C. R. Houle.
1979. Effects of dietary lipids on the growth and acceptability. (flavor) of channel catfish (*Ictalurus punctatus*). Pages 87-103 in J. E. Halver and K. Tiews, editors. Finfish nutrition and fishfeed technology; proceedings of a world symposium sponsored and supported by European Inland Fisheries Advisory Commission (EIFAC), International Council for the Exploration of the Sea (ICES), and International Union of Nutritional Sciences (IUNS), Hamburg. 20-23 June 1978. Volume 2. Heeneman Verlagsgesellschaft mbH, Berlin.

Compares growth rate and tissue composition of channel catfish fed crude fish oil, refined (bleached) fish oil, and corn oil at levels up to 15% in purified diets.

Fordiani, T. R., and H. G. Ketola.
1980. Effect of heat treatment on first limiting amino acid of soybean meal in diets of rainbow trout (*Salmo gairdneri*). Page 196 in Abstracts of the 72nd Annual Meeting of the American Society of Animal Science, Cornell University, Ithaca, New York. 27-30 July 1980. (Abstract 222)

Effects of feeding heat treated soybean meal and supplemental amino acids to rainbow trout.

Giudice, J.
1977. Overwintering feed program important: warmwater fish need proper nutrition in cold months. Commercial Fish Farmer and Aquaculture News 4(1):13-14.

The need for winter feeding, frequency and related problems are addressed.

## FEEDS, FEEDING, AND NUTRITION (CONTINUED)

Greenland, D. C., and R. L. Gill.
1979. Multiple daily feedings with automatic feeders improve growth and feed conversion rates of channel catfish. Progressive Fish-Culturist 41(3):151-153.

The effects of multiple daily feedings on the growth and feed conversion rates of tank reared channel catfish. Increasing the number of feedings from one to two to four results in progressively improved feed conversion rates and higher net yields when feeding level is below the satiation level.

Halver, J. E., J. A. Coates, C. W. Deyoe, H. K. Dupree, G. Post, and R. O. Sinnhuber, Subcommittee on Fish Nutrition.
1973. Nutrient requirements of domestic animals: nutrient requirements of trout, salmon, and catfish. Series No. 11. National Academy of Sciences, Washington, D. C. 57 pages.

Summarizes the nutrient requirements of trout, salmon and catfish intensively reared in fish culture. Sections on feed processing and storage, composition of feeds, and typical test diets complete the report.

Hastings, W. H.
1972. Catfish feeds and feeding. Pages 23-25 in Proceedings of the Catfish Production and Management Conference, sponsored by the Cooperative Extension Service, Veterinary Medicine College, State Natural History Survey, and Division of University Extension, University of Illinois of Urbana-Champaign, Illinois. 16-17 June 1972.

A general overview of practical catfish feeds and techniques for feeding.

Hastings, W. H.
1972. Feeding domestic freshwater fish. Agricultural Engineering 53(12):16-17.

Management techniques on the mechanical feeding of fish in intensive production systems. Discusses self-feeders.

## FEEDS, FEEDING, AND NUTRITION (CONTINUED)

Hastings, W. H., and L. M. Dickie.
1972. Feed formulation and evaluation. Pages 327-374 in J. E. Halver, editor. Fish nutrition. Academic Press, Inc., New York.

Provides an overview of the ingredients and formulations of manufactured feeds for fish.

Hastings, W. H., B. Hinson, D. Tackett, and B. Simco.
1972. Monitoring channel catfish use of a demand feeder. Progressive Fish-Culturist 34(4):204-206.

Contains a detailed description of the circuitry of a demand feeder.

Hastings, W. H.
1973. Phase feeding for catfish. Progressive Fish-Culturist 35(4):195-196.

An overview on the phase feeding technique in intensive production of channel catfish.

Hastings, W. H., and B. A. Simco.
1973. Fish feed management and processing have impact on profits. Pages 29-40 in Proceedings of the 1973 Fish Farming Conference and Annual Convention Catfish Farmers of Texas, Texas A & M University, College Station, Texas. 5-6 January 1973.

A discussion on manufacturing methods for finished feeds for catfish. Included are ingredients pretreatment, vitamin supplementation, and floating/sinking feed manufacture. Some information is directed to the technique of phase feeding.

Hastings, W. H., and B. A. Simco.
1973. Impact of fish feed management and processing on profit. Feedstuffs 45(18):33-34, 72.

Discusses the techniques and value of vitamin supplementation, phase feeding techniques and other feeds and feeding methods for commercial production.

## FEEDS, FEEDING, AND NUTRITION (CONTINUED)

Hastings, W. H.
1974. Attempts to lower feed costs. Pages 80-90 in Proceedings of the 1974 Fish Farming Conference and Annual Convention Catfish Farmers of Texas, Texas A & M University, College Station, Texas. 3-4 January 1974.

Summarizes research on feeds containing different ratios of plant and animal materials fed in different water temperatures. Emphasizes phase feeding as a technique to maximize feed utilization

Hughes, S. G.
1980. Redetermination of the dietary riboflavin requirement of the rainbow trout (*Salmo gairdneri*) and the lenticular cataract associated with riboflavin deficiency. Page 40 in Abstracts of the 36th Annual Northeast Fish and Wildlife Conference: Fisheries Abstracts, Ellenville, New York. 27-30 April 1980. (Abstract).

Results show the requirement of rainbow trout for riboflavin is between 1 and 3 mg/kg of diet. The cataract which results from riboflavin deficiency is unique in its histopathogenesis, making its differentiation from other nutritionally induced cataracts relatively simple.

Hughes, S. G.
1980. Re-evaluation of dietary riboflavin requirement of rainbow trout (*Salmo gairdneri*). M. S. Thesis. Cornell University, Ithaca, New York. 92 pages.

Report re-examines the quantitative dietary riboflavin requirement of fingerling rainbow trout, and describes deficiency signs including growth depression, cataracts and enzyme abnormalities.

Hughes, S. G.
1980. Re-evaluation of the dietary riboflavin requirement of rainbow trout. U.S. Fish and Wildlife Service, Research Information Bulletin 80-18. 1 page.

A revision of the quantitative riboflavin requirement of rainbow trout which might realize the fish culturist a savings of $140 per metric ton of feed used. Includes a characterization of ocular lesions in trout fed diets deficient in riboflavin.

## FEEDS, FEEDING, AND NUTRITION (CONTINUED)

Hughes, S. G., G. L. Rumsey, and H. G. Ketola.
1980. Biomicroscopic and histologic pathology of the eye in riboflavin-deficient rainbow trout (*Salmo gairdneri*). Page 205 in Abstracts of the 72nd Annual Meeting of the American Society of Animal Science, Cornell University, Ithaca, New York. 27-30 July 1980. (Abstract 243).

Describes the developmental pathology in the cornea and lens of the eye of rainbow trout fed graded levels of riboflavin.

Ketola, H. G.
1974. Amino acid supplementation of soybean meal in diets of Atlantic salmon and rainbow trout. Pages 13 in Proceedings of the Third Fish Feed and Nutrition Workshop, Tunison Laboratory of Fish Nutrition, Cortland, New York. 24-25 September 1974. (Abstract).

Adding a mixture (methionine, lysine, leucine, valine, and threonine) of amino acids to a fish diet containing soybean meal, significantly improves growth rate.

Ketola, H. G.
1974. Phosphorus requirement of Atlantic salmon. Page 13 in Proceedings of the Third Fish Feed and Nutrition Workshop, Tunison Laboratory of Fish Nutrition, Cortland, New York. 24-25 September 1974. (Abstract).

The effect of adding phosphorus to fish diets containing plant sources of protein. Additions of inorganic phosphorus up to 0.6% of diet increases growth rate.

Ketola, H. G.
1975. Mineral supplementation of diets containing soybean meal as a source of protein for rainbow trout. Progressive Fish-Culturist 37(2):73-75.

Measures the effect of supplementing a fish diet with dicalcium phosphate and ash prepared from fish protein concentrate.

Ketola, H. G.
1975. Nutrient requirements of fish -- a review. Pages 48-54 in Proceedings of the 1975 Cornell Nutrition Conference for Feed Manufacturers, Buffalo, New York. 28-30 October 1975. Cornell University, Ithaca, New York.

A review of the known requirements for vitamins and minerals of fishes.

## FEEDS, FEEDING, AND NUTRITION (CONTINUED)

Ketola, H. G.
1975. Requirement for dietary choline by lake trout. Federation Proceedings 34(3):883. (Abstract 3758).

Information on the quantitative requirement for dietary choline by fingerling lake trout. Choline is required for optimum growth and for prevention of fatty livers.

Ketola, H. G.
1975. Requirement of Atlantic salmon for dietary phosphorus. Transactions of the American Fisheries Society 104(3):548-551.

Results of feeding fish graded levels of inorganic phosphorus in a basal diet containing plant phosphorus. Supplements of inorganic phosphorus up to 0.6% of the diet significantly improved growth, feed utilization, and bone ash content.

Ketola, H. G.
1976. Choline metabolism and nutritional requirement of lake trout (*Salvelinus namaycush*). Journal of Animal Science 43(2):474-477.

A study designed to determine the choline needs and metabolism in young lake trout.

Ketola, H. G.
1976. Quantitative nutritional requirements of fishes for vitamins and minerals. Feedstuffs 48(7):42, 44-45.

Reviews the quantitative requirements of fishes for dietary vitamins and minerals. Summarizes the published descriptions of the symptoms of deficiencies of watersoluble vitamins, fat soluble vitamins and minerals in various species.

Ketola, H. G.
1977. Qualitative requirements and utilization of nutrients: fishes. Pages 411-418 in M. Rechcigl, Jr., editor. CRC handbook series in nutrition and food. Section D: Nutritional requirements. Volume 1. Comparative and qualitative requirements. CRC (Chemical Rubber Company) Press, Cleveland, Ohio.

Reviews the qualitative need and the uses of nutrients by fish.

## FEEDS, FEEDING, AND NUTRITION (CONTINUED)

Ketola, H. G.
1978. Nutritional requirements and feeding of selected coolwater fishes: a review. Progressive Fish-Culturist 40(4):127-132.

Reviews the state-of-the-art about knowledge of nutritional needs of coolwater fishes, i.e., yellow perch, European perch, walleye, smallmouth bass, northern pike, muskellunge, and the northern pike X muskellunge hybrid. Identifies some key articles dealing with physiology, management, and general husbandry associated with the culture of these fishes.

Ketola, H. G.
1979. Influence of dietary lysine on "fin rot," survival, and growth of fry of rainbow trout. Fish Health News 8(2):vi.

The beneficial effects of dietary lysine on caudal fin condition, growth, and survival of young rainbow trout fed corn gluten meal as the only source of protein.

Ketola, H. G.
1979. Requirement of rainbow trout (*Salmo gairdneri*) for lysine when fed diets containing corn gluten meal. Page 245 in Abstracts of the 71st Annual Meeting of the American Society of Animal Science, University of Arizona, Tucson, Arizona. 28 July - 1 August 1979. (Abstract 255).

Information on the quantitative lysine requirement of rainbow trout fed corn gluten meal.

Ketola, H. G.
1980. Amino acid requirements of fishes: a review. Pages 43-47 in Proceedings of the 1980 Cornell Nutrition Conference for Feed Manufacturers, Syracuse, New York. 4-6 November 1980. Cornell University, Ithaca, New York.

A review of published dietary requirements of fishes for amino acids, recent findings at the Tunison Laboratory concerning amino acid nutrition of trout, specific signs of amino acid deficiency, and the use of fish egg amino acid patterns as a guideline to formulating new feeds or for further studies on amino acid requirements.

## FEEDS, FEEDING, AND NUTRITION (CONTINUED)

Ketola, H. G.
1980. Commercial soybean meal in diets of Atlantic salmon. U.S. Fish and Wildlife Service, Research Information Bulletin 80-14. 1 page.

Effects of feeding heated soybean meal and supplemental amino acids on the growth of young salmon.

Ketola, H. G.
1980. Influence of various dietary fish meals on the growth of fry of Atlantic salmon. Fish Health News 9(1):i-ii.

A comparative study of the differences in response in body weight increase of Atlantic salmon to capelin, whitefish, anchovy, and the new Canadian herring (cuttings) meal (65% protein) with that of salmon fed Norwegian whole herring meal.

Ketola, H. G.
1980. A new comparative look at fish meals in diets of Atlantic salmon. U.S. Fish and Wildlife Service, Research Information Bulletin 80-16. 1 page.

Compares the growth and survival of salmon fed different types and sources of fish meals.

Lovell, R. T., and H. K. Dupree.
1974. Replacement value of catfish waste meal for marine fish meal in catfish feeds. Pages 47-53 in Proceedings of the Third Fish Feed and Nutrition Workshop, Tunison Laboratory of Fish Nutrition, Cortland, New York. 24-25 September 1974.

Catfish waste meal is a valuable source of animal protein for catfish diets and may replace fish meal when fed at high levels (29%) and at high water temperatures (above 70°F).

Luquet, P., and G. L. Rumsley [*sic*].
1979. Formulation et technologie des aliments secs pour poisson. (Formulation and technology of dry diets for fish). Pages 21-35 in J. E. Halver and K. Tiews, editors. Finfish nutrition and fishfeed technology; proceedings of a world symposium sponsored and supported by European Inland Fisheries Advisory Commission (EIFAC), International Council for the Exploration of the Sea (ICES), and International Union of Nutritional Sciences (IUNS), Hamburg. 20-23 June 1978. Volume 2. Heeneman Verlagsgesellschaft mbH, Berlin. (In French).

Reports recent progress in developing low moisture diets for fish.

## FEEDS, FEEDING, AND NUTRITION (CONTINUED)

McCartney, T. H.
1974. The effect of supplemental dietary pepsin on the growth and chemistry of fingerling brown trout. Pages 27-28 *in* Proceedings of the Third Fish Feed and Nutrition Workshop, Tunison Laboratory of Fish Nutrition, Cortland, New York. 24-25 September 1974. (Abstract).

Addition of pepsin to the diet appears to have a negative effect upon growth, percent gain, and protein efficiency ratio of the trout. Fish fed a pepsin supplemented diet exhibit an intense feeding activity, which indicates pepsin may act as a flavor potentiator or olfactory stimulant.

Meyers, S. P., D. P. Butler, and W. H. Hastings.
1972. Alginates as binders for crustacean rations. Progressive Fish-Culturist 34(1):9-12.

Discusses the various binders and formulations of feeds for shrimp.

Page, J. W.
1978. Dietary sulfur requirements of fish: nutritional, pathological, and biochemical criteria. Ph. D. Dissertation. Cornell University, Ithaca, New York. 136 pages.

Effects of feeding fish semipurified diets deficient in methionine and cystine, sulfur containing amino acids.

Podoliak, H. A.
1974. Effect of water chemistry on calcium utilization by trout. Page 26 *in* Proceedings of the Third Fish Feed and Nutrition Workshop, Tunison Laboratory of Fish Nutrition, Cortland, New York. 24-25 September 1974. (Abstract).

A study on calcium utilization by steelhead rainbow trout in normal, saline, hard, or saline plus hard waters.

Post, G., J. W. Andrews, Jr., C. W. Deyoe, H. K. Dupree, R. T. Lovell, T. Nose, and R. P. Wilson, Subcommittee on Warmwater Fish Nutrition.
1977. Nutrient requirements of domestic animals: nutrient requirements of warmwater fishes. National Academy of Sciences, Washington, D. C. 78 pages.

This publication is concerned with the basic nutrient requirements and the deficiency signs in warmwater fishes. It can be used as a guide in formulation and manufacture of warmwater fish diets. Tables of feedstuff composition and typical diets are included.

## FEEDS, FEEDING, AND NUTRITION (CONTINUED)

Post, G., and G. L. Rumsey.
1978. Nutrient requirements of fishes. Pages 84-96 in National Research Council. Subcommittee on Laboratory Animal Nutrition. Nutrient requirements of domestic animals: nutrient requirements of laboratory animals. Series No. 10. 3d revised edition. National Academy of Sciences, Washington, D. C.

A guide for maintaining experimental fishes in an optimum state of nutrition to obtain desirable performance.

Poston, H. A., and R. N. DiLorenzo.
1973. Tryptophan conversion to niacin in the brook trout (*Salvelinus fontinalis*). Proceedings of the Society for Experimental Biology and Medicine 144(1):110-112.

Results of assays for activity of liver enzymes associated with tryptophan metabolism in trout.

Poston, H. A.
1974. Effect of feeding brown trout (*Salmo trutta*) a diet pelleted in dry and moist forms. Journal of the Fisheries Research Board of Canada 31(11):1824-1826.

Comparison of the growth, body composition, and efficiency of trout fed different levels of water in a pelleted diet.

Poston, H. A.
1974. Effect of source of diet lipids upon growth, body chemistry, and fatty acid metabolism of juvenile Atlantic salmon (*Salmo salar*). In Abstracts of the Symposium on Lipids of Marine Animals, Philadelphia, Pennsylvania. 29 September - 2 October 1974. Journal of the American Oil Chemists' Society 51(7):521-A. (Abstract 84).

Results of feeding Atlantic salmon different sources of lipids, namely herring, soybean, raw linseed, or safflower oil.

Poston, H. A.
1974. Effect of source of dietary lipids on growth and body composition of Atlantic salmon. Page 24 in Proceedings of the Third Fish Feed and Nutrition Workshop, Tunison Laboratory of Fish Nutrition, Cortland, New York. 24-25 September 1974. (Abstract).

A production-type fish diet containing a low level of fat is supplemented with either herring, soybean, raw linseed, or safflower oil at 4.5% of the dry diet. Analysis of variance shows no statistically significant effect of diet on growth, body composition or mortality.

## FEEDS, FEEDING. AND NUTRITION (CONTINUED)

Poston, H. A.
1974. Interrelationships between dietary Vitamin E and selenium by Atlantic salmon. Page 24 in Proceedings of the Third Fish Feed and Nutrition Workshop, Tunison Laboratory of Fish Nutrition, Cortland, New York. 24-25 September 1974. (Abstract).

Investigations on the possible need for dietary selenium, and the interrelationships between the requirement for this mineral and Vitamin E by Atlantic salmon.

Poston, H. A., and T. H. McCartney.
1974. Effect of dietary biotin and lipid on growth, stamina, lipid metabolism and biotin-containing enzymes in brook trout (*Salvelinus fontinalis*). Journal of Nutrition 104(3):315-322.

An investigation of the effects of dietary biotin and fat on the growth, feed conversion, swimming stamina, carcass and liver lipid levels, and liver fatty acid composition of juvenile brook trout.

Poston, H. A.
1975. Influence of dietary protein and energy on swimming stamina, growth, and body composition of brown trout. Progressive Fish-Culturist 37(4):257-261.

Results indicate that swimming stamina, growth, and efficiency of feed utilization of juvenile brown trout improve with increased consumption of protein. The level of dietary cellulose is negatively correlated with growth, body composition, and intake of nutrients, but it is not significantly correlated with energy/protein ratios or stamina.

Poston, H. A.
1975. Level of dietary biotin required for optimum growth, feed utilization and swimming stamina by juvenile lake trout. Federation Proceedings 34(3):884. (Abstract 3766).

Results of feeding fingerling lake trout graded levels of dietary biotin.

## FEEDS, FEEDING, AND NUTRITION (CONTINUED)

Poston, H. A.
1976. Optimum level of dietary biotin for growth, feed utilization, and swimming stamina of fingerling lake trout (*Salvelinus namaycush*). Journal of the Fisheries Research Board of Canada 33(8):1803-1806.

The effects of feeding lake trout graded levels of biotin in a semipurified diet. Results indicate that young lake trout need no more than 0.1 ppm biotin for optimum growth and feed conversion, but require from 0.5 to 1.0 ppm for optimum swimming stamina.

Poston, H. A.
1976. Relative effect of two dietary water-soluble analogues of menaquinone on coagulation and packed cell volume of blood of lake trout (*Salvelinus namaycush*). Journal of the Fisheries Research Board of Canada 33(8):1791-1793.

The effect of feeding different sources and levels of dietary vitamin K to lake trout.

Poston, H. A., G. F. Combs, Jr., and L. Leibovitz.
1976. Vitamin E and selenium interrelations in the diet of Atlantic salmon (*Salmo salar*): gross, histological and biochemical deficiency signs. Journal of Nutrition 106(7):892-904.

Characterizes some of the gross, histologic and biochemical signs of vitamin E and selenium deficiencies in young Atlantic salmon and delineates some of the interrelations between the dietary requirements of these two nutrients.

Poston, H. A., and G. F. Combs, Jr.
1979. Interrelationships between requirements for dietary selenium, Vitamin E, and L-ascorbic acid by Atlantic salmon (*Salmo salar*) fed a semipurified diet. Fish Health News 8(4):vi-vii.

Evidence for the interdependence of dietary selenium, Vitamin E and Vitamin C in salmonid nutrition.

Poston, H. A., and G. F. Combs, Jr.
1980. Nutritional implications of tryptophan catabolizing enzymes in several species of trout and salmon. Proceedings of the Society for Experimental Biology and Medicine 163(4):452-454.

Discusses the activities of some liver enzymes of five species of salmonids in relation to conversion of dietary tryptophan to niacin.

## FEEDS, FEEDING, AND NUTRITION (CONTINUED)

Reece, D. L., D. E. Wesley, G. A. Jackson, and H. K. Dupree.
1974. A blood meal-rumen contents blend as a partial or complete substitute for fish meal in channel catfish, *Ictalurus punctatus* (Rafinesque), diets. Pages 32-46 in Proceedings of the Third Fish Feed and Nutrition Workshop, Tunison Laboratory of Fish Nutrition, Cortland, New York. 24-25 September 1974.

Rumen, blended with a high protein component such as blood meal, provides a satisfactory protein source in catfish rations.

Reece, D. L., D. E. Wesley, G. A. Jackson, and H. K. Dupree.
1975. A blood meal-rumen contents blend as a partial or complete substitute for fish meal in channel catfish diets. Progressive Fish-Culturist 37(1):15-19.

Dried rumen contains approximately 11.7% protein, an amount insufficient to satisfy the dietary requirements for catfish. If the rumen is blended with a high protein component such as blood meal, which contains 80-86% protein, a sufficient level is attained for incorporation into catfish rations as a primary protein source.

Rumsey, G. L.
1972. The new fish industry in the United States. Pages 9-13 in Proceedings of the 1972 Cornell Nutrition Conference for Feed Manufacturers, Buffalo, New York. 31 October - 2 November 1972.

Focuses on the potential role of feeds and feeding in intensive fish culture.

Rumsey, G. L.
1973. The protein situation in fish feeds and feeding. American Fishes and U. S. Trout News 18(7):6-11.

Compares the potential use of various protein substitutes in relation to the nutritional requirements of fish.

Rumsey, G. L.
1974. Practical type starter and grower diets for Atlantic salmon. Pages 73-75 in Proceedings of the Third Fish Feed and Nutrition Workshop, Tunison Laboratory of Fish Nutrition, Cortland, New York. 24-25 September 1974.

A comparison of diets for pre-smolt Atlantic salmon.

## FEEDS, FEEDING, AND NUTRITION (CONTINUED)

Rumsey, G. L., and H. G. Ketola.
1975. Amino acid supplementation of casein in diets of Atlantic salmon (*Salmo salar*) fry and of soybean meal for rainbow trout (*Salmo gairdneri*) fingerlings. Journal of the Fisheries Research Board of Canada 32(3):422-426.

Results show significant improvement in growth when casein and soybean meal are supplemented with mixtures of amino acids to simulate fish protein.

Rumsey, G. L., and H. G. Ketola.
1975. Practical diets for Atlantic salmon (*Salmo salar*) fry and fingerlings. Progressive Fish-Culturist 37(4):253-256.

Evaluates the suitability for Atlantic salmon of five diets formulated with commercially available feedstuffs. Two of these diets are estimated to retail at one-half the cost of imported commercial feeds.

Rumsey, G. L.
1977. Fish nutrition - recent advances. Pages 16-40 in Proceedings from the International Symposium on Diseases of Cultured Salmonids, Tavolek, Inc., Seattle, Washington. 4-6 April 1977.

State-of-the-art in feeds and feeding fish.

Rumsey, G. L.
1978. Recent advances in nutrition of salmonids. Salmonid 2(4):14-17, 21, 26.

Focuses on research about nutritionally-related fish eye problems, and on the role of dietary energy in fish production -- two major areas of fish nutrition in which significant progress has been made within the past few years.

Rumsey, G. L.
1980. Antioxidants in compounded feeds. Pages 177-182 in K. W. Chow, editor. Fish feed technology; lectures presented at the FAO/UNDP training course in fish feed technology, College of Fisheries, University of Washington, Seattle, Washington. 9 October - 15 December 1978. Aquaculture Development and Coordination Programme ADCP/REP/80/11. Food and Agriculture Organization of the United Nations, Rome.

The use of antioxidants to prevent rancidity in fish feeds.

## FEEDS, FEEDING, AND NUTRITION (CONTINUED)

Rumsey, G. L.
1980. Novel diets for aquaculture. Pages 351-353 in K. W. Chow, editor. Fish feed technology; lectures presented at the FAO/UNDP training course in fish feed technology, College of Fisheries, University of Washington, Seattle, Washington. 9 October - 15 December 1978. Aquaculture Development and Coordination Programme ADCP/REP/80/11. Food and Agriculture Organization of the United Nations, Rome.

The potential use of encapsulated, flaked, and extruded diets for larval species in aquaculture.

Rumsey, G. L.
1980. Stability of micro-ingredients in fish feed. Pages 225-229 in K. W. Chow, editor. Fish feed technology; lectures presented at the FAO/UNDP training course in fish feed technology, College of Fisheries, University of Washington, Seattle, Washington. 9 October - 15 December 1978. Aquaculture Development and Coordination Programme ADCP/REP/80/11. Food and Agriculture Organization of the United Nations, Rome.

Discusses factors affecting the stability of feed ingredients of small particle size.

Smith, R. R.
1976. Metabolizable energy of feedstuffs for trout. Feedstuffs 48(23):16, 21.

Supplies digestibility and metabolizable energy values of feedstuffs for rainbow trout.

Smith, R. R.
1977. Recent research involving full-fat soybean meal in salmonid diets. Salmonid 1(4):8-11, 18.

The effects of feeding heat-treated raw soybeans on the digestibility and metabolic energy of rainbow trout.

## FEEDS, FEEDING, AND NUTRITION (CONTINUED)

Smith, R. R., and G. L. Rumsey.
1977. Nutrient utilization by fish. Pages 320-326 in P. V. Fonnesbeck, L. E. Harris, and L. C. Kearl, editors. Proceedings of the First International Symposium on Feed Composition, Animal Nutrient Requirements, and Computerization of Diets, Utah State University, Logan, Utah. 11-16 July 1976. Utah Agricultural Experiment Station, Utah State University, Logan, Utah.

Discusses the metabolism and utilization of energy and other nutrients in fish. Data are provided on the digestibility and metabolizable energy values for common feed ingredients and purified materials.

Smith, R. R., G. L. Rumsey, and M. L. Scott.
1978. Heat increment associated with dietary protein, fat, carbohydrate and complete diets in salmonids: comparative energetic efficiency. Journal of Nutrition 108(6):1025-1032.

The measurement by direct calorimetry of the heat increment, i.e., the heat production following consumption of food, in salmonids fed a complete diet and purified fat, protein, and carbohydrate.

Smith, R. R., G. L. Rumsey, and M. L. Scott.
1978. Net energy maintenance requirements of salmonids as measured by direct calorimetry: effect of body size and environmental temperature. Journal of Nutrition 108(6)1017-1024.

Discusses the use of direct calorimetry to measure effects of body size and water temperature on metabolic rate of salmonids.

Smith, R. R.
1979. Methods for determination of digestibility and metabolizable energy of feedstuffs for finfish. Pages 453-459 in J. E. Halver and K. Tiews, editors. Finfish nutrition and fish feed technology; proceedings of a world symposium sponsored and supported by European Inland Fisheries Advisory Commission (EIFAC), International Council for the Exploration of the Sea (ICES), and International Union of Nutritional Sciences (IUNS), Hamburg. 20-23 June 1978. Volume 2. Heeneman Verlagsgesellschaft mbH, Berlin.

Reviews methods for obtaining digestibility and metabolizable energy values of feedstuffs for fish.

## FEEDS, FEEDING, AND NUTRITION (CONTINUED)

Smith, R. R.
1979. Summary report of discussions. Pages 515-516 in J. E. Halver and K. Tiews, editors. Finfish nutrition and fishfeed technology; proceedings of a world symposium sponsored and supported by European Inland Fisheries Advisory Commission (EIFAC), International Council for the Exploration of the Sea (ICES), and International Union of Nutritional Sciences (IUNS), Hamburg. 20-23 June 1978. Volume 2. Heeneman Verlagsgesellschaft mbH, Berlin.

A two-page summary on standardization of methods and terminology in finfish nutrition, designs of experiments and their evaluation, techniques for determining digestibility and metabolizable energy of feedstuffs, and standardization of methods for testing fish quality.

Smith, R. R.
1980. Recent advances in nutrition: clay in trout diets. Salmonid 4(4):16-18.

Inclusion of some types of clay at about 10% of the diet can significantly reduce feed/gain ratios and increase rate of gain.

Smith, R. R., M. C. Peterson, and A. C. Allred.
1980. Effect of leaching on apparent digestion coefficients of feedstuffs for salmonids. Progressive Fish-Culturist 42(4):195-199.

Information on the effect of method of partitioning solid and liquid fractions of fecal matter (i.e., settling, centrifuging, or filtering) on digestibility and metabolizable energy of 55 diet ingredients.

Sneed, K. E., W. H. Hastings, and H. K. Dupree.
1972. Accomplishments and future priorities in warmwater fish nutrition. Pages 151-155 in Progress in fishery and food science; fiftieth anniversary celebration symposium, University of Washington, Seattle, Washington. 1972. University of Washington Publications in Fisheries, New Series, Volume 5.

Discusses culture systems of the future, including waste heat from power generation, and provides some prediction of future nutritional needs for fish in these systems.

## FEEDS, FEEDING, AND NUTRITION (CONTINUED)

Stanley, J. G.
1974. Energy balance of white amur fed egeria. Hyacinth Control Journal 12(May):62-66.

Results of feeding egeria to grass carp. Energy is largely supplied by protein, while carbohydrate is largely converted into fat.

Stanley, J. G.
1974. Nitrogen and phosphorus balance of grass carp, *Ctenopharyngodon idella*, fed elodea, *Egeria densa*. Transactions of the American Fisheries Society 103(3):587-592.

Grass carp fed elodea exhibit a negative nitrogen balance in metabolism, suggesting that food having a higher protein content is required for normal growth. Because a third of the phosphorus contained in food is retained, a combination of aquatic plants and grass carp might afford an effective method for removing phosphorus from water.

Stanley, J. G., J. E. Ellis, J. B. Jones, and W. H. Hastings.
1975. Utilization of algae by fish. Final report to Hercules Incorporated, Wilmington, Delaware. U.S. Fish and Wildlife Service, Fish Farming Experimental Station, Stuttgart, Arkansas. [20] pages.

*Spirulina platensis* is successfully cultured and fed to bigmouth buffalo and blue tilapia; *Spirogyra* is fed to grass carp. Results give rate of growth and food conversion. It is concluded that an algae/fish aquaculture system is feasible but presently not economical

Stanley, J. G., and J. B. Jones.
1976. Feeding algae to fish. Aquaculture 7(3):219-223.

Determines rates of food conversion and growth in bigmouth buffalo and blue tilapia fed *Spirulina platensis* and in grass carp fed *Spirogyra*.

## MISCELLANEOUS CULTURE TECHNIQUES AND EQUIPMENT

Brandt, T. M., and C. B. Schreck.
1974. Collection and maintenance of fishing bait from streams and ponds. Publication 602. Extension Division, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. 19 pages.

Techniques of collecting, handling, and maintaining aquatic bait such as minnows, crayfish, salamanders and hellgrammites from the natural environment.

Brauhn, J., K. Hamel, B. Kohler, and D. Miller.
1975. A portable high-pressure cleaner for tanks and raceways. Progressive Fish-Culturist 37(4):234-235.

Construction and operation of a portable high pressure sprayer that can be used for cleaning fish tanks and raceways.

Ellis, J. E., and D. L. Tackett.
1976. Settleable solids in the discharge water from farm ponds. Pages 65-68 in Proceedings of the 1976 Fish Farming Conference and Annual Convention Catfish Farmers of Texas, Texas A & M University, College Station, Texas. 20-21 July 1976.

A study of techniques used to lower the settleable solids discharged from fish culture ponds.

Ellis, J. E., and D. L. Tackett.
1977. Cones for sampling accumulated solids in ponds. Progressive Fish-Culturist 39(2):66.

A note describing a simple technique for collecting accumulations of organic and inorganic particulate matter from pond bottoms.

Giudice, J.
1977. You asked for it! Water quality is key factor in fish farming. Commercial Fish Farmer and Aquaculture News 3(6):35.

Diagnostic indicators of poor water quality and remedial action to be taken.

## MISCELLANEOUS CULTURE TECHNIQUES AND EQUIPMENT (CONTINUED)

Greenland, D. C.
1972. Harvesting and loading farm-raised catfish. Pages 23-27 in Presentations at the Inland Fishing Gear Workshop, Northwest Fishery Research Center, Seattle, Washington. 14-16 March 1972.

A review of channel catfish harvesting and loading equipment and techniques.

Greenland, D. C., J. E. Ellis, and R. L. Gill.
1972. Operating and design criteria of an adjustable horizontal bar grader for sorting channel catfish. Progressive Fish-Culturist 34(4):186-190.

Describes the bar grader for sorting channel catfish to size. This adjustable grader is inexpensive, can be constructed by the farmer, is durable, is easy to operate, gives predictable results, does not injure the fish, has a high capacity, and can be used to sort a variety of sizes of channel catfish.

Greenland, D. C., and R. L. Gill.
1972. Development and operation efficiency of a catfish grader. Progressive Fish-Culturist 34(2):76-80.

Describes the Kelso bar grader for sorting channel catfish.

Greenland, D. C., and S. L. Weaver.
1972. Mechanized net storage reel. Progressive Fish-Culturist 34(2):114-115.

Design criteria for seine storage reel.

Greenland, D. C., and R. L. Gill.
1974. A diversion screen for grading pond-raised channel catfish. Progressive Fish-Culturist 36(2):78-79.

Describes the use of a grading screen around a feeding station to divert large fish to other feeding sites and to allow small fish to enter the feeding station.

## MISCELLANEOUS CULTURE TECHNIQUES AND EQUIPMENT (CONTINUED)

Greenland, D. C., and R. L. Gill.
1974. Trapping pond-raised channel catfish. Progressive Fish-Culturist 36(2):72-77.

Reviews trapping devices for harvesting channel catfish and describes successful traps developed at the Fish Farming Development Center.

Greenland, D. C., and R. L. Gill.
1976. Harvesting channel catfish from farm ponds with drop seines. Pages 60-64 in Proceedings of the 1976 Fish Farming Conference and Annual Convention Catfish Farmers of Texas, Texas A & M University, College Station, Texas. 20-21 July 1976.

Includes description of drop seine traps and compares catches of channel catfish for different sized traps.

Greenland, D. C., R. R. Carter, R. L. Gill, D. L. Tackett, and J. E. Ellis.
1979. Harvesting monosex grass carp. Progressive Fish-Culturist 41(1):50.

Procedures and catch efficiencies for harvesting monosex grass carp from small ponds. Nylon seines 49 m long, 1.8 m deep, with 1.3 cm square mesh is used to catch the grass carp.

Kincaid, H. L., W. R. Bridges, and B. von Limbach.
1976. Rearing system for small groups of experimental fish. Progressive Fish-Culturist 38(1):8-10.

A fish rearing system applicable to the production of many small distinct groups of experimental fish. The basic unit consists of a mother tank, a tank top assembly, and five rearing units. Complete plans for construction of the basic unit are provided.

Martin, M.
1979. Innovations for the fish farmer. Commercial Fish Farmer and Aquaculture News 5(3):15-16.

Innovative techniques and equipment discovered by individual fish farmers that may be helpful to other farmers.

## MISCELLANEOUS CULTURE TECHNIQUES AND EQUIPMENT (CONTINUED)

Martin, M.
1979. You asked for it! "Must" reading: new review of live hauling. Commercial Fish Farmer and Aquaculture News 5(2):38-39, 41.

The readers' attention is directed to the U.S. Fish and Wildlife Service publication, *Transportation of Warmwater Fishes*. A review of fish transportation equipment and problems, of interest to all persons directly or indirectly involved with hauling fish. This publication is now combined with a section on *Transportation of Salmonid Fishes*, and the two published as the U.S. Fish and Wildlife Service's *Manual of Fish Culture, Section G. Fish Transportation*.

Martin, M.
1980. You asked for it! Plastic bag hauling of small live fish. Aquaculture Magazine 7(1):40-41.

A review of plastic bag hauling, a common method for transporting eggs or small fish by airplane.

Martin, M., D. Greenland, and D. Tackett.
1980. You asked for it! How to cheaply improve water for hatching fish eggs. Aquaculture Magazine 6(5):35.

A simple, inexpensive method for improving water quality for hatching fish eggs.

Parker, N. C., and G. A. Jackson.
980. External standpipe drain system for fish tanks. Progressive Fish-Culturist 42(1):53-54.

An external standpipe drain system for fish tanks, which requires no valves and is constructed of polyvinylchloride pipes and joints, is successfully used in tanks with capacities of 114, 378 and 1590 L. Construction details and cost estimates are provided.

Sneed, K., K. Allen, and J. E. Ellis.
1975. Fish farming and hydrophonics [*sic*]. Aquaculture and the Fish Farmer 1(1):11, 18-20.

A popular article on the use of waste water from fish production to grow selected agricultural crops.

## MISCELLANEOUS CULTURE TECHNIQUES AND EQUIPMENT (CONTINUED)

Tackett, D. L., and J. E. Ellis.
1976. Variations within water quality measurements. Pages 69-76 in Proceedings of the 1976 Fish Farming Conference and Annual Convention Catfish Farmers of Texas, Texas A & M University, College Station, Texas. 20-21 July 1976.

Discusses variations in water analysis due to water sampling techniques.

## MORPHOLOGY

Allen, D. M., W. N. McFarland, F. W. Munz, and H. A. Poston.
1973. Changes in the visual pigments of trout. Canadian Journal of Zoology 51(9):901-914.

Reports results of the examination of four species of trout for changes in proportion of two retinal visual pigments (rhodopsin and porphyropsin) under experimental and natural conditions.

Brauhn, J. L., and J. McCraren.
1975. Ovary maturation in channel catfish. Progressive Fish-Culturist 37(4):209-212.

Describes ovarian development observed in channel catfish samples collected from adults at thirty day intervals throughout the year.

Stanley, J. G., C. J. Biggers, and D. E. Schultz.
1976. Morphology of androgenetic and gynogenetic grass carp, *Ctenopharyngodon idella* (Valenciennes). Journal of Fish Biology 9(6):523-528.

A study to determine if inheritance is strictly matroclinus in gynogenesis and patroclinus in androgenesis in crosses between grass carp and carp, where immediate characteristics indicate hybrid origin.

## PHYSIOLOGY

Davis, K. B., N. C. Parker, and M. A. Suttle.
1979. Plasma corticosteroid concentrations and secretion rates in channel catfish (*Ictalurus punctatus*): effect of temperature, time of day and fish density. In Abstracts of the Annual Meeting of the American Society of Zoologists, Tampa, Florida. 27-30 December 1979. American Zoologist 19(3):900. (Abstract 237).

Measurements of the plasma corticosteroid concentrations and secretion rates in yearling channel catfish.

McCartney, T. H.
1974. Some observations on changes in the Na+ - K+ dependent adenosine triphosphatase activity of gills and kidney associated with the parr-smolt transformation of Atlantic salmon (*Salmo salar*). Masters thesis. State University of New York, Upstate Medical Center, Syracuse, New York. 56 pages.

Correlates changes in activity of gill and kidney ATPase with smoltification of Atlantic salmon parr.

McCartney, T. H.
1976. Sodium-potassium dependent adenosine triphosphatase activity in gills and kidneys of Atlantic salmon (*Salmo salar*). Comparative Biochemistry and Physiology 53A(4):351-353.

Information on the seasonal changes in gill and kidney sodium-potassium ATPase during transformation of parr to smolt under hatchery conditions.

Pauley, G. B.
1974. Physicochemical properties of the natural agglutinins of some mollusks and crustaceans. In E. Cohen, editor. Biomedical perspectives of agglutinins of invertebrate and plant origins; papers from the conference, New York Academy of Sciences, New York. 21-23 May 1973. Annals of the New York Academy of Sciences 234:145-160.

Report on the naturally occurring agglutinins in the California sea hare, *Aplysia californica*, the crayfish, *Procambarus clarkii*, and the blue crab, *Callinectes sapidus*. They are compared with agglutinins of other mollusks and crustaceans.

## PHYSIOLOGY (CONTINUED)

Plosila, D. W., W. T. Keller, T. J. McCartney, and D. S. Robson.
1972. Effects of sperm storage and dilution on fertilization of brook trout eggs. Progressive Fish-Culturist 34(3):179-181.

Recommends that brook trout sperm be stored at approximately 2°C for not longer than 24 hours before use, that greater quantities of stored milt be used in lieu of fresh milt, and that proportion of dilution water to milt be 1:1 when using small quantities of milt in the dry method of ferilization.

Poston, H. A.
1978. Neuroendocrine mediation of photoperiod and other environmental influences on physiological responses in salmonids: a review. U.S. Fish and Wildlife Service, Technical Paper 96. 14 pages.

A review of the effects of water temperature and photoperiod on growth, reproduction and smoltification in fish.

Reinitz, G. L.
1976. Comparison of techniques for stabilizing hemoglobins of rainbow trout (*Salmo gairdneri*) during frozen storage. Comparative Biochemistry and Physiology 55B(3):357-358.

Evaluates the stability of rainbow trout hemoglobins during frozen storage in the oxy form, carboxy form and cyanomet form for 3 to 21 days at -20°C.

Reinitz, G. L., and J. Rix.
1977. Effect of tricaine methanesulfonate (MS-222) on hematocrit values in rainbow trout (*Salmo gairdneri*). Comparative Biochemistry and Physiology 56C(2):115-116.

Discusses the physiological effect of MS-222 on hematocrit values and the rate of recovery from those effects.

Thomas, A. E., and M. J. Donahoo.
1977. Differences in swimming performance among strains of rainbow trout (*Salmo gairdneri*). Journal of the Fisheries Research Board of Canada 34(2):304-307.

Outlines factors that affect swimming performance and identifies differences among three strains tested. There is no correlation between swimming performance and growth rate to 189 days of age.

## GENETICS, VARIATION STUDIES, HYBRIDIZATION

Beck, M. L., C. J. Biggers, and H. K. Dupree.
1980. Karyological analysis of *Ctenopharyngodon idella*, *Aristichthys nobilis*, and their $F_1$ hybrid. Transactions of the American Fisheries Society 109(4):433-438.

Documents the research on deteriming the chromosome number for the bighead carp, grass carp, and the (3N) triploid hybrid, with speculation on the origin of the third set of chromosomes of the hybrid.

Biggers, C. J., D. Tackett, and B. A. Simco.
1972. Inheritance study of five individual matings of channel catfish *Ictalurus punctatus*. ASB (Association of Southeastern Biologists) Bulletin 19(2):54. (Abstract 255).

A note comparing variations in growth within single spawns and those made by fish from different spawns.

Bridges, B., and H. L. Kincaid.
1978. Finding fish to fit a fishery: the objective of the Fish and Wildlife Service's Fish Genetics Laboratory. Wyoming Wildlife 42(5):24-27.

The development of a strain evaluation program designed to identify fish strains for use in general or specific management applications.

Bridges, W. R., and B. von Limbach.
1972. Inheritance of albinism in rainbow trout. Journal of Heredity 63(3):152-153.

Describes the inheritance of albinism in rainbow trout as a single locus autosomal recessive trait.

Gharrett, A. J., R. C. Simon, and J. D. McIntyre.
1977. Reassociation and hybridization properties of DNAs from several species of fish. Comparative Biochemistry and Physiology 56B(1): 81-85.

Describes the reassociation and hybridization properties of the DNAs of 10 species of fish. Examines the utility of DNA studies in assessing the phylogenetic relationships between fishes.

## GENETICS, VARIATION STUDIES, HYBRIDIZATION (CONTINUED)

Giudice, J. J.
1972. Catfish breeding, selection and hybridization. Pages 12-16 in J. G. Dillard, editor. Proceedings of the Missouri Catfish Conference, Lake Ozark, Missouri. Extension Division, University of Missouri, Columbia, Missouri. 10-11 March 1970.

The principles involved in hybridization and selective breeding and their application to the culture of catfish.

Kincaid, H. L.
1972. A preliminary report on the genetic aspects of 150-day family weights in hatchery rainbow trout. Pages 562-565 in Proceedings of the Fifty-second Annual Conference of Western Association of State Game and Fish Commissioners, Portland, Oregon. 16-19 July 1972.

Results of two generations of selection for accelerated 150 day family mean fish weights. Discusses heritability estimation and inbreeding.

Kincaid, H. L.
1975. Iridescent metallic blue color variant in rainbow trout. Journal of Heredity 66(2):100-102.

Describes a blue color variant in rainbow trout that is associated with accelerated growth rate. The mode of inheritance of this variant is discussed.

Kincaid, H. L.
1976. Effects of inbreeding on rainbow trout populations. Transactions of the American Fisheries Society 105(2):273-280.

Effect of inbreeding on egg viability, abnormal fry frequency, feed conversion efficiency, and fingerling survival in rainbow trout to an age of 147 days. The methodology for the detection of inbreeding in fish populations is presented.

Kincaid, H. L.
1976. Inbreeding in rainbow trout (*Salmo gairdneri*). Journal of the Fisheries Research Board of Canada 33(11):2420-2426.

Results of inbreeding in rainbow trout populations through one year of age. Also describes the effects of increasing levels of inbreeding within experimental populations.

## GENETICS, VARIATION STUDIES, HYBRIDIZATION (CONTINUED)

Kincaid, H. L.
1976. Inbreeding in salmonids. Pages 33-37 in T. Y. Nosho and W. K. Hershberger, editors. Salmonid genetics: status and role in aquaculture. Report of a workshop, University of Washington, Seattle. 9 March 1976. Washington Sea Grant, WSG-WO-76-2. Division of Marine Resources, University of Washington, Seattle, Washington.

Discusses the effects of inbreeding and outlines general approaches that can be taken to minimize the rate of inbreeding accumulation in broodstocks.

Kincaid, H. L.
1977. Rotational line crossing: an approach to the reduction of inbreeding accumulation in trout brood stocks. Progressive Fish-Culturist 39(4):179-181.

Describes a mating system which can by employed by fisheries personnel at the brood stock level to control the rate of inbreeding accumulation.

Kincaid, H. L., W. R. Bridges, and B. von Limbach.
1977. Three generations of selection for growth rate in fall-spawning rainbow trout. Transactions of the American Fisheries Society 106(6):621-628.

Describes selection procedure, rate of progress and realized heritability information from a selection program based on 147 day mean fish weight. Program employs a combination of family and individual selection.

Kincaid, H. L.
1979. Development of standard reference lines of rainbow trout. Transactions of the American Fisheries Society 108(5):457-461.

Describes the performance of two lines developed for use as standard reference lines over a six-year period from 1972-1977. Discusses alternate approaches for establishing reference lines for use as controls in continuing research programs.

## GENETICS, VARIATION STUDIES, HYBRIDIZATION (CONTINUED)

Kincaid, H. L.
1979. Measurement of inbreeding effects in trout after release from the hatchery. Page 5 in Abstracts of papers presented at the American Fisheries Society 109th Annual Meeting, West Yellowstone, Montana. 12-15 September 1979. (Abstract).

Effects of inbreeding, i.e., growth rate and recovery rate, measured in rainbow trout 6, 12, and 18 months after stocking as fingerlings. Inbreeding consistently yields lower growth rate and lower percent recovery as compared to the outbred families.

Martin, M.
1973. Practical farmer's guide to buffalo cross-breeding. American Fish Farmer and World Aquaculture News 4(2):6-8.

The title is self-explanatory.

Reinitz, G. L.
1977. Electrophoretic distinction of rainbow trout (*Salmo gairdneri*), west-slope cutthroat trout (*S. clarki*), and their hybrids. Journal of the Fisheries Research Board of Canada 34(8):1236-1239.

Establishes an electrophoretic profile for rainbow trout and west-slope cutthroat trout. Identifies individual loci that can be used to distinguish between the two species and the hybrid.

Reinitz, G. L.
1977. Inheritance of muscle and liver types of supernatant NADP-dependent isocitrate dehydrogenase in rainbow trout (*Salmo gairdneri*). Biochemical Genetics 15(5/6):445-454.

The inheritance of NADP-dependent isocitrate dehydrogenase phenotypes in muscle and liver tissues of the rainbow trout.

Reinitz, G. L.
1977. Tests for association of transferrin and lactate dehydrogenase phenotypes with weight gain in rainbow trout (*Salmo gairdneri*). Journal of the Fisheries Research Board of Canada 34(12):2333-2337.

Identifies a relationship between transferrin phenotypes and fish weight. The genetic conditions that could produce this are discussed.

## GENETICS, VARIATION STUDIES, HYBRIDIZATION (CONTINUED)

Schultz, D. E., C. J. Biggers, and J. G. Stanley.
1975. Electrophoresis of blood proteins of hybrid and gynogenic carp. ASB (Association of Southeastern Biologists) Bulletin 22(2):77.

Electrophoretic studies of blood proteins from two-year-old gynogenic and hybrid carp suggest the presence of homozygosity in the gynogenic carp. Electrophoretic migration of several proteins of the hybrid fish appear to be intermediate to the proteins of the parent species.

Simon, R. C.
1977. Selective breeding: the "specialist" approach *versus* crossbreeding: the "generalist" approach. Pages 41-45 in Proceedings of the session on Fish Genetics--Fundamentals and Implications to Fish Management, supported by the Great Lakes Fishery Commission and co-sponsored with the American Fisheries Society. Held at the Annual Meeting of the International Association for Great Lakes Research, University of Michigan, Ann Arbor, Michigan. 10-12 May 1977. Great Lakes Fishery Commission, Ann Arbor, Michigan.

Compares selective breeding and cross-breeding, giving the advantages and pitfalls of each technique. Data are provided to illustrate management applications.

Simon, R. C.
1980. Guidelines for maintenance of fish strain registries. Page 6 in Abstracts of papers presented at the 109th Annual Meeting of the American Fisheries Society, West Yellowstone, Montana. 12-15 September 1979. (Abstract).

Abstract of a report on the genetic variation within strains and an approach for the maintenance of fish strain registry.

Sneed, K. E., and F. P. Meyer.
1972. An overview of current and proposed selective breeding of catfishes in the United States. Pages 20-22 in Proceedings of the Catfish Production and Management Conference, sponsored by the Cooperative Extension Service, Veterinary Medicine College, State Natural History Survey, and Division of University Extension, University of Illinois of Urbana-Champaign, Illinois. 16-17 June 1972.

A summary of the status of selective breeding programs for channel catfish.

## GENETICS, VARIATION STUDIES, HYBRIDIZATION (CONTINUED)

Stanley, J. G., and K. E. Sneed.
1974. Artificial gynogenesis and its application in genetics and selective breeding of fishes. Pages 527-536 in J. H. S. Blaxter, editor. The early life history of fish; proceedings of an International Symposium, Dunstaffnage Marine Research Laboratory of the Scottish Marine Biological Association at Oban, Scotland. 17-23 May 1973. Springer-Verlag, New York.

Gynogenesis is potentially valuable for providing unisex populations, in genetic studies and selective breeding for locating and selecting recessive genes and in studies of chromosome linkage and crossovers. It is especially useful in selective breeding, since homozygosity may be achieved in fewer generations than with inbreeding.

Stanley, J. G., J. M. Martin, and J. B. Jones.
1975. Gynogenesis as a possible method for producing monosex grass carp (*Ctenopharyngodon idella*). Progressive Fish-Culturist 37(1):25-26.

A study using gynogenesis for producing monosex grass carp. Results suggest that the yield of gynogenetic fish is too meager for mass production of monosex fish, even though it is a useful tool for selective breeding.

Stanley, J. G.
1976. Female homogamety in grass carp (*Ctenopharyngodon idella*) determined by gynogenesis. Journal of the Fisheries Research Board of Canada 33(6):1372-1374.

Results from artificially induced gynogenesis show that the tendency for grass carp to become diploid is not strongly heritable.

Stanley, J. G.
1976. Production of hybrid, androgenetic, and gynogenetic grass carp and carp. Transactions of the American Fisheries Society 105(1): 10-16.

A study of the techniques used to produce sterile or non-reproducing chinese grass carp (white amur) and other carp.

## GENETICS, VARIATION STUDIES, HYBRIDIZATION (CONTINUED)

Stanley, J. G.
1976. A review of methods for obtaining monosex fish and progress report on production of monosex white amur. Journal of Aquatic Plant Management 14:68-70.

A practical and useful description of methods for producing monosex grass carp, and a review of methods that yield monosexes in other fishes.

Stanley, J. G., and A. E. Thomas.
1978. Absence of sex reversal in unisex grass carp fed methyltestosterone. Pages 194-199 in R. O. Smitherman, W. L. Shelton, and J. H. Grover, editors. Symposium on Culture of Exotic Fishes; presented at Aquaculture/Atlanta/'78, Georgia. 4 January 1978. Fish Culture Section, American Fisheries Society, Department of Fisheries and Allied Aquacultures, Auburn University, Auburn, Alabama.

Methyltestosterone administered to gynogenetic offspring is ineffective in inducing sex transformation.

Thomas, A. E.
1976. Catfish breeding: growth potential and effects of inbreeding related to results with rainbow trout. Pages 97-102 in Proceedings of the 1976 Fish Farming Conference and Annual Convention Catfish Farmers of Texas, Texas A & M University, College Station, Texas. 20-21 July 1976.

Practices and procedural methods used in fish genetics that could be useful towards channel catfish genetics improvement.

Yant, D. R., R. O. Smitherman, and O. L. Green.
1976. Production of hybrid (blue x channel) catfish and channel catfish in ponds. Pages 82-86 in W. A. Rogers, W. Wegener, and L. E. Williams, Jr., editors. Proceedings of the Twenty-Ninth Annual Conference Southeastern Association of Game and Fish Commissioners, Saint Louis, Missouri. 12-15 October 1975.

Comparison of the net yield, feed conversion, survival, ease of harvest by seining, uniformity of size, weight per unit length, dress-out percentage, chemical composition, and morphology of the hybrid catfish and channel catfish.

## BEHAVIOR

Ellis, J. E.
1974. Controlling fish behavior with electrical stimuli. Pages 30-32 in Proceedings of the 1974 Fish Farming Conference and Annual Convention Catfish Farmers of Texas, Texas A & M University, College Station, Texas. 3-4 January 1974.

A description of three basic types of electrical stimuli that incite fish activity.

Ellis, J. E.
1974. The jumping ability and behavior of green sunfish (*Lepomis cyanellus*) at the outflow of a 1.6-ha pond. Transactions of the American Fisheries Society 103(3):620-623.

Effects of plunging water flow on the behavior of green sunfish.

Ellis, J. E.
1974. Observations on the jumping and escapement of white amur. Progressive Fish-Culturist 36(1):15.

Suggests that white amur can escape from impoundments having low dams and become established in adjacent water.

Ellis, J. E.
1977. Learned behavior in channel catfish (*Ictalurus punctatus*) and its potential application in management. Pages 28-31 in Proceedings of the Sixth Inland Commercial Fisheries Workshop, North Little Rock, Arkansas. 22-24 February 1977.

A study describing the response of channel catfish to an electric shock stimulus.

Tarrant, R. M., Jr.
1974. Recapturing channel catfish in cages from which they were released. Pages 33-39 in Proceedings of the 1974 Fish Farming Conference and Annual Convention Catfish Farmers of Texas, Texas A & M University, College Station, Texas. 3-4 January 1974.

A study using conditioned response to capture fish in cages where they were reared and fed.

## PARASITES AND DISEASES - GENERAL

Anderson, D. P.
1974. Fish immunology. Book 4 in S. F. Snieszko and H. R. Axelrod, editors. Diseases of fishes. T. F. H. Publications, Inc., Neptune City, New Jersey. 239 pages.

A textbook on the practical aspects of fish immunology. There are five chapters, each with its own bibliography (a total of 233 references). Topics include the protective mechanisms in fishes, types of immune response, and techniques used in the diagnosis and prevention of fish diseases.

[Anderson, D. P., and O. L. Wright].
1975. Fish disease serodiagnosis. FAO Aquaculture Bulletin 7(3-4):21.

This is the first announcement of the formation of the Biologics Section at the National Fish Health Research Laboratory. Biologics include antisera, antigens, and experimental reagents used in fish disease serodiagnosis.

Anderson, D. P., O. L. Dixon, and B. S. Roberson.
1979. The immune response of rainbow trout in a standardized environment: a model for vaccine antigenicity tests. Fish Health News 8(2):iv-v.

A standardized kinetics curve is demonstrated for rainbow trout held in the environment of spring water at the National Fish Health Research Laboratory.

Anderson, D. P.
1980. Advances in fish vaccines. Page [19] in Proceedings of the Fourth Biennial Workshop of the Fish Health Section, American Fisheries Society and the Twenty-first Western Fish Disease Conference. Cover title: Proceedings of the Joint 4th Biennial Fish Health Section and Fish Disease Workshops, Seattle, Washington. 24-26 June 1980. (Abstract).

The report briefly describes recent findings in fish immunology and antigen analysis of fish disease agents.

## PARASITES AND DISEASES - GENERAL (CONTINUED)

Anderson, D. P., O. W. Dixon, and D. W. McDaniel.
1980. Fish biologics: products and protocols for fish disease serodiagnosis in sport fisheries and commercial aquaculture. Page 9 in Abstracts of the Fish Culture Section of the American Fisheries Society, Aquaculture/New Orleans/'80, Louisiana. 6-8 March 1980. (Abstract).

During the past 5 years the Biologics Section at the National Fish Health Research Laboratory distributed over 2500 vials of fish biologics to federal, state, university, private, and foreign research personnel and field biologists.

Anderson, D. P., and B. Merchant.
1980. Immunologic memory in rainbow trout injected with DNP-KLH or DNP-Ficoll. In Abstracts of the Annual Meeting of the American Society of Zoologists, Seattle, Washington. 27-30 December 1980. American Zoologist 20(4):863. (Abstract 800).

A heightened immune response to the DNP hapten is observed in fish given booster injections of KLH-DNP. The DNP conjugated T-independent carrier Ficoll does not induce a secondary response.

Bullock, G. L., R. E. Putz, and S. F. Snieszko.
1973. Fish diseases. Pages 1172-1183 in O. H. Siegmund, editor. The Merck Veterinary Manual. 4th edition. Merck and Company, Inc., Rahway, New Jersey.

A brief description of the principal bacterial, parasitic, viral, and noninfectious diseases of fishes with emphasis on cultured species. Where appropriate, control procedures for diseases are described.

Bullock, G. L., and K. Wolf.
1975. Recent advances in the diagnosis and detection of some infectious diseases of fishes. Pages 99-104 in Proceedings of the Third U. S. - Japan Meeting on Aquaculture, Tokyo, Japan. 15-16 October 1974. Special Publication of Fishery Agency, Japanese Government and Japan Sea Regional Fisheries Research Laboratory, Niigata, Japan.

A brief discussion of advances during the last 10-15 years in diagnostic and detection procedures for the important bacterial and viral pathogens.

## PARASITES AND DISEASES - GENERAL (CONTINUED)

Bullock, G. L., S. F. Snieszko, and K. Wolf.
1977. Disease agents: viral and bacterial. In G. Post and W. G. Klontz, editors. Glossary of fish health terms. Fish Health Section, American Fisheries Society, [Bethesda, Maryland]. 48 pages.

Defines terminology regarding bacterial and viral diseases of fish.

Bullock, G. L., F. P. Meyer, S. F. Snieszko, and K. E. Wolf.
1979. Fish diseases. Pages 1247-1262 in O. H. Siegmund, editor. The Merck Veterinary Manual. 5th edition. Merck and Company, Inc., Rahway, New Jersey.

An update of material in the 4th edition.

Dixon, O. W.
1978. Biologics from the National Fish Health Research Laboratory: their preparation and distribution. Pages 62-72 in G. L. Buterbaugh, editor. Proceedings of the Second Annual Meeting of the Potomac Chapter of the American Fisheries Society, Cacapon State Park, West Virginia. 11-12 May 1978.

Presents the history and operation of the Biologics Section of the National Fish Health Research Laboratory and gives a description of the preparation of bacterial and viral antigens. A listing of the biological reagents that have been standardized is included.

Elkan, E., and H. -H. Reichenbach-klinke.
1974. Color atlas of the diseases of fishes, amphibians, and reptiles. Edited by M. Landolt. T. F. H. Publications, Inc., Neptune City, New Jersey. 256 pages.

A companion, color atlas to the authors' text, *Principal diseases of lower vertebrates,* 1965.

Ellis, J. E.
1974. A review of the literature on the use of Masoten in fisheries. U.S. Fish and Wildlife Service, Literature Review LR#74-13. PB 235 452. National Technical Information Service, Springfield, Virginia. 62 pages.

A complete review of literature concerning Masoten, a parasiticide, in fisheries. There are also two tables of data relating to the toxicity of Masoten to various organisms.

## PARASITES AND DISEASES - GENERAL (CONTINUED)

Griffin, B. R., and K. Wolf.
1977. Antibody-antigen mediated neutrophil chemotaxis in teleost fishes. Page 115 in Abstracts of the Annual Meeting of the American Society for Microbiology, New Orleans, Louisiana. 8-13 May 1977. (Abstract E207).

Trout neutrophils are chemotactically attracted to up to 10% whole trout serum and are stimulated by antigen-antibody complexes to higher levels of migratory activity.

Heartwell, C. M., III.
1975. Immune response and antibody characterization of the channel catfish (*Ictalurus punctatus*) to a naturally pathogenic bacterium and virus. U.S. Fish and Wildlife Service, Technical Paper 85. 34 pages.

A study of the immune response of the channel catfish to the bacterium, *Chondrococcus columnaris* and to the virus, channel catfish virus, the kinetics of the immune response, and the partial characterization of the antibodies produced. A literature review of the immune response in fishes is also included.

Herman, R. L.
1972. The principles of therapy in fish diseases. Pages 141-151 in L. E. Mawdesley-Thomas, editor. Diseases of fish; proceedings of a symposium organized by the Fisheries Society of the British Isles and the Zoological Society of London, held at the Zoological Society of London. 20-21 May 1971. Symposia of the Zoological Society of London, Number 30. Academic Press, Inc., London.

The advantages and disadvantages of various techniques of administering chemotherapeutics to fish are outlined. Other factors which influence the choice of drugs are noted.

Herman, R. L.
1975. Some lesions in the heart of trout. Pages 331-342 in W. E. Ribelin and G. Migaki, editors. The pathology of fishes. University of Wisconsin Press, Madison, Wisconsin.

Several bacterial and viral lesions in the heart are discussed. Overall, the heart of fishes seems little affected by disease.

## PARASITES AND DISEASES - GENERAL (CONTINUED)

Hoffman, G. L., and F. P. Meyer.
1974. Parasites of freshwater fishes: a review of their control and treatment. J. C. Landolt, editor. T. F. H. Publications, Inc., Neptune City, New Jersey. 224 pages.

A major review of drugs and chemicals used for treatment and control of fish parasites. Treatment tables are provided for each of the major groups of parasites, with each group being arranged alphabetically by genera of parasite and then alphabetically by name of drug or chemical. Includes name of fish host, level and method of dosage, number and frequency of application, effectiveness of treatment, and the pertinent bibliographic reference.

[Hoffman, G. L.].
1976. Diagnostic services available. Commerical Fish Farmer and Aquaculture News 2(6):23.

A listing of individuals and laboratories that provide fish disease diagnostic services.

Hoffman, G. L.
1976. Diagnostic services available. In 1977 Buyers' Guide. Sixth Annual [edition]. Commercial Fish Farmer, Little Rock, Arkansas. Published in Commercial Fish Farmer and Aquaculture News 3(1):43.

A listing of individuals and laboratories that provide fish disease diagnostic services.

Hoffman, G. L.
1976. Fish diseases and parasites in relation to the environment. In S. Egusa, editor. Recent advances in fish pathology; proceedings of an international seminar sponsored by Japan Research Group of Fish Pathology and Committee VI, 3 Nutrition and Production of Fish in the International Union of Nutrition Science, Tokyo, Japan. 11-12 August 1975. Fish Pathology 10(2):123-128.

Attempts to relate fish parasite epizootics to the known environmental parameters. Some parameters, e.g., temperature, condition of fish, density of fish, have an obvious influence on certain parasite populations. Bacterial diseases are strongly influenced by organic overload and related changes.

## PARASITES AND DISEASES - GENERAL (CONTINUED)

Hoffman, G. L.
1976. Symposium 4 - Diseases of fishes. Introduction. Pages 125-126 in L. A. Page, editor. Wildlife diseases; proceedings of the Third International Wildlife Disease Conference, Institute for Zoology and Hydrobiology, University of Munich, Munich. 1975. Plenum Press, New York.

Introduction to a symposium chaired by G. L. Hoffman. Briefly outlines the history of fish disease work in the U. S. and discusses future needs.

Hoffman, G. L., and J. R. Lichtenfels.
1976. Detecting and identifying parasites in foods: practical aids. Page 175 in Program of the 36th Annual Meeting of the Institute of Food Technologists, Anaheim, California. 6-9 June 1976. (Abstract 292).

Methods for identifying parasites in foods, including fish.

Hoffman, G. L., and R. Heckman.
1977. Disease agents: parasitic. In G. Post and W. G. Klontz, editors. Glossary of fish health terms. Fish Health Section, American Fisheries Society [Bethesda, Maryland]. 48 pages.

Defines terminology regarding parasitic diseases of fishes.

Hoffman, G. L., and A. J. Mitchell.
1977. Diagnostic services available. In 1978 Buyers' Guide. Seventh Annual [edition]. Commercial Fish Farmer, Little Rock, Arkansas. Published as a special detachable supplement in Commercial Fish Farmer and Aquaculture News 4(1):33-34, 36-37.

A listing of individuals who provide limited or general fish disease diagnostic assistance. It is arranged by state with personnel or laboratories listed alphabetically.

Hoffman, G. L.
1978. Recent parasitic problems in North American cultured fishes. Pages 185-186 in Proceedings of the Fourth International Congress of Parasitology, Workshop C, Warsaw, Poland. 19-26 August 1978. (Abstract).

Brief account of recent epizootics of Ich, *Chilodonella hexasticha*, *Leraea elegans*, *Bothriocephalus acheilognathi*, *Ambiphrya ameiuri*, and *Dicauda atherinoidi*.

## PARASITES AND DISEASES - GENERAL (CONTINUED)

Hoffman, G. L., and A. J. Mitchell.
1978. Fish disease diagnosis and control. When to ask for help... and how to go about it. Commercial Fish Farmer and Aquaculture News 4(4):20-23.

Discusses how and where to submit fish for disease diagnosis.

Hoffman, G. L., and A. J. Mitchell.
1979. Diagnostic services available. Commercial Fish Farmer and Aquaculture News 5(3):37-39.

A listing of individuals who provide limited or general fish disease diagnostic assistance. It is arranged by state with personnel or laboratories listed alphabetically.

Hoffman, G. L., and A. J. Mitchell.
1979. Diagnostic services available. Pages 65-67, 69-70, 72 in Aquaculture Magazine 1980 Buyer's Guide. Ninth annual edition. Aquaculture Magazine, Little Rock, Arkansas.

A listing of individuals who provide limited or general fish disease diagnostic assistance. It is arranged by state with personnel or laboratories listed alphabetically. This year the list also includes Canadian diagnostic serivces available.

Hoffman, G. L.
1980. Advances in freshwater fish parasitology. Page [20] in Proceedings of the Fourth Biennial Workshop of the Fish Health Section, American Fisheries Society and the Twenty-first Western Fish Disease Conference. Cover title: Proceedings of the Joint 4th Biennial Fish Health Section and Fish Disease Workshops, Seattle, Washington. 24-26 June 1980.

Recent parasitic epizootics, mostly from the U. S., are discussed. Points to the need for precise identification of certain species and better control methods.

Hoffman, G. L.
1980. Parasitic diseases of laboratory fishes and their control. Synapse 13(3):16-20.

A discussion of parasitic diseases of fishes used in laboratory experiments. Includes a summary of control measures.

## PARASITES AND DISEASES - GENERAL (CONTINUED)

Hoffman, G. L., and A. J. Mitchell.
1980. Diagnostic services available. Pages 22-26 in Aquaculture Magazine 1981 Buyer's Guide. Tenth annual edition. Aquaculture Magazine, Little Rock, Arkansas.

A listing of American and Canadian individuals who provide limited or general fish disease diagnostic assistance. It is arranged by state and province with personnel or laboratories listed alphabetically.

Lucký, Z.
1977. Methods for the diagnosis of fish diseases. (Metodické Návody k Diagnostice Nemocí Ryb, 1971). G. L. Hoffman, editor. Published for the U.S. Fish and Wildlife Service by Amerind Publishing Company, New Delhi. National Technical Information Service, Springfield, Virginia. TT 75-58005. 140 pages.

A textbook on fish diseases used in a Czechoslovakian veterinary college.

McDaniel, D. W., editor.
1979. Procedures for the detection and identification of certain fish pathogens. Fish Health Blue Book. Revised edition. Fish Health Section, American Fisheries Society, [Bethesda, Maryland]. 118 pages.

A compilation of state-of-the-art procedures contributed by various fish health professionals. The booklet is intended as a practical methods guide for fish disease diagnosticians.

Meyer, F. P.
1972. Diseases of economic importance in the culture of warmwater fishes. Pages 125-128 in R. W. Moore, editor. Progress in fishery and food science; fiftieth anniversary celebration symposium, University of Washington, Seattle, Washington. 1972. University of Washington Publications in Fisheries, New Series, Volume 5.

A review of diseases peculiar to broodstock, to fry and fingerlings, and to fish of marketable size. Emphasis is on channel catfish and golden shiners, the two fishes which contribute over 90% of commercial warmwater fish production in the U. S.

## PARASITES AND DISEASES - GENERAL (CONTINUED)

Meyer, F. P.
1972. Observations on diseases of catfishes. Pages 17-20 in J. G. Dillard, editor. Proceedings of the Missouri Catfish Conference, Lake Ozark, Missouri. 10-11 March 1970. Extension Division, University of Missouri, Columbia, Missouri.

Some remarks on the problem diseases of catfish, and their control.

Meyer, F. P.
1975. The pathology of the major diseases of catfish. Pages 275-286 in W. E. Ribelin and G. Migaki, editors. The pathology of fishes. University of Wisconsin Press, Madison, Wisconsin.

The clinical and gross signs of the most significant viral, bacterial, parasitic, and nutritional diseases of channel catfish.

Mitchell, A. J., and G. L. Hoffman.
1978. Species identification of fish parasites in diagnositcs [*sic*]. Page 53 in Proceedings of the Third Biennial Fish Health Section/AFS and Ninth Annual Midwest Fish Disease Workshops. Cover title: Proceedings of the Joint 3rd Biennial Fish Health Section and 9th Annual Midwest Fish Disease Workshops, Kansas City, Missouri. 15-18 August 1978. (Abstract).

Reasons why proper species identification of parasites is both needed and practical.

[Plumb, J., and G. L. Hoffman].
1975. Fish diseases and parasites. Pages 5-7 in Freshwater foodfish (and crawfish): research needs in the southern region. State Agricultural Experiment Stations and U.S. Department of Agriculture, Aquatic Food Animal Task Force Report 4.07. Department of Research Information, Agricultural Experiment Station, Auburn University, Auburn, Alabama.

Identifies research needs for controlling diseases and parasites of fish.

Podoliak, H. A.
1974. A review of the literature on the use of calcium hypochlorite in fisheries. Final report. U.S. Fish and Wildlife Service, Literature Review 74-05. PB 235 444. National Technical Information Service, Springfield, Virginia. 282 pages.

This extensive report reviews the uses, safety and effects of calcium hypochlorite with fish.

## PARASITES AND DISEASES - GENERAL (CONTINUED)

Poppensiek, G. C., R. F. Hutton, G. W. Klontz, J. B. Pearce, G. Post, S. F. Snieszko, and L. M. Sprague, Subcommittee on Aquatic Animal Health.
1973. Aquatic animal health. National Academy of Sciences, Washington, D. C. 46 pages.

Information on the nature and control of diseases of fishes.

Reichenbach-Klinke, H. -H.
1973. Fish pathology; a guide to the recognition and treatment of diseases and injuries of fishes, with emphasis on environmental and pollution problems. Collaboration by M. Landolt. Translated by C. Ahrens. T. F. H. Publications, Inc., Neptune City, New Jersey. 512 pages.

A text for the practical worker as well as for the fish pathologist, the fishery biologist and the veterinarian specializing in fish pathology, and the parasitologist. A chapter is devoted to the effects of pollution on fish.

Snieszko, S. F.
1972. Progress in fish pathology in this century. Pages 1-15 in L. E. Mawdesley-Thomas, editor. Diseases of fish; proceedings of a symposium organized by the Fisheries Society of the British Isles and the Zoological Society of London, held at the Zoological Society of London. 20-21 May 1971. Symposia of the Zoological Society of London, Number 30. Academic Press, Inc., London.

A review of the development of fish pathology covering seventy years. Selected diseases caused by parasites, bacteria, and viruses are included, with emphasis on the host-pathogen relationship as affected by the environment.

Snieszko, S. F.
1973. Diseases of fishes and their control in the U. S. A. Pages 55-66 in Two Lakes Fifth Fishery Management Training Course Report, Two Lakes, Romsey, Hampshire. 5-7 October 1973. Janssen Services, London.

Discusses the most important diseases of salmonid fishes and their control.

## PARASITES AND DISEASES - GENERAL (CONTINUED)

Snieszko, S. F.
1973. Recent advances in scientific knowledge and developments pertaining to diseases of fishes. Advances in Veterinary Science and Comparative Medicine 17:291-314.

A review article on the etiologic and pathologic features of viral, bacterial, parasitic, nutritional, neoplastic and environmental diseases of fishes. Gas bladder disease of carp is also discussed. Includes methods of disease control by selection and breeding, immunization, chemoprophylaxis and chemotherapy.

Snieszko, S. F.
1974. Diseases and nutrition of ornamental fishes. Pet Age 4(3):8, 10, 17, 19-20, 23-24, 27.

A general discussion of fish diseases written for the tropical fish hobbyist and for the dealer in ornamental fishes. Included are a list of the diseases of fishes caused by viruses, bacteria, and parasites, a list of chemicals used most frequently for the control of infectious diseases of fishes, and a list of textbooks and symposia on the subject.

Snieszko, S. F.
1974. Types of fish culture and their relation to diseases: how to prevent and control diseases of fish. Pages 66-90 in Two Lakes Sixth Fishery Management Training Course Report, Two Lakes, Romsey, Hampshire. 4-6 October 1974. Janssen Services, London.

Discusses the most important diseases of salmonid fishes and their control.

Snieszko, S. F.
1975. Chemicals used most frequently for control of infectious diseases of fishes. Fish Health News 4(3):2-7.

Alphabetical list of chemicals and drugs used for the control of fish diseases as well as the mode for their use.

## PARASITES AND DISEASES - GENERAL (CONTINUED)

Snieszko, S. F.
1975. A comprehensive list of the most important diseases of fishes and the drugs and chemicals used for their control. Tropical Fish Hobbyist 24(#238, Number 4):14-15, 19-20, 22, 24, 27-28, 32, 34.

An alphabetical list of the most important diseases of fishes caused by viruses, bacteria, and plant and animal parasites, information about the causative organisms, and the most frequently used methods of control. Both generic and common trade names are given for the drugs and chemicals listed.

Snieszko, S. F.
1975. History and present status of fish diseases. Journal of Wildlife Diseases 11(4):446-459.

A review of fish diseases caused by parasites, bacteria, viruses, and inadequate nutrition. Methods of disease control are also included.

Snieszko, S. F.
1978. Control of fish diseases. In A. J. Novotny, M. M. Sigel, and S. Waterman, editors. Health, disease, and disease prevention in cultured aquatic animals; selected papers presented at a conference sponsored by Norden Laboratories, Lincoln, Nebraska. 9-10 June 1975. Marine Fisheries Review 40(3):65-68. (Marine Fisheries Review Paper 1301).

A discussion of epizootiological principles of fish diseases. Treatment methods are presented in tabular form.

Snieszko, S. F., G. L. Hoffman, and P. E. McAllister.
1979. Fish diseases. Pages 269-274 in R. D. Teague and E. Decker, editors. Wildlife conservation: principles and practices. The Wildlife Society, Washington, D. C.

Highly condensed information on diseases of fishes written for the wildlife conservationist.

## PARASITES AND DISEASES - GENERAL (CONTINUED)

Snieszko, S. F.
1980. Epizootiology of fish diseases. (Epizootologie der Fischkrankheiten). In H. -H. Reichenbach-Klinke, editor. Beiträge zur Fischpathologie und -toxicologie (Contributions to fish pathology and fish toxicology). Gustav Fischer Verlag, Stuttgart. Also published as Fisch und Umwelt (Fish and Environment) 8:1-17.

A lecture on the factors such as genetics, quality of the environment, and the species and pathogenicity of disease producing agents that contribute to outbreaks of diseases of fishes.

Warr, G. W., D. Deluca, and B. R. Griffin.
1979. Membrane immunoglobulin is present on thymic and spenic lymphocytes of the trout *Salmo gairdneri*. Journal of Immunology 123(2):910-917.

Antisera produced by rabbits against purified trout IgM did not appear to recognize carbohydrate antigens on either serum IgM or on the surface of thymus lymphocytes. Trout thymocytes possess surface immunoglobulin determinants that are antigenically indistinguishable from serum IgM.

Wolf, K.
1975. Fish health -- some concepts, constraints, and comparisons. In J. C. Baiardi and G. D. Ruggieri, editors. Aquatic sciences; papers from a workshop honoring Ross F. Nigrelli, New York Academy of Sciences, New York. 8 November 1973. Annals of the New York Academy of Sciences 245:4-15.

An overview presentation in which fish health in husbandry is compared with that of domestic poultry. The material also discusses fish health research and the direction of effort toward solving the most serious problems.

## BACTERIAL DISEASES

Anderson, D. P.
1978. Passive hemolytic plaque assay as a means for detecting antibody producing cells in rainbow trout immunized with the O-antigen of enteric redmouth bacteria. Ph. D. Dissertation. University of Maryland, College Park, Maryland. 107 pages.

This is the first report of the passive hemolytic plaque assay with fish. The immune response of rainbow trout injected with graded doses of the *Yersinia ruckeri* O-antigen is followed by sheep red blood cells tagged with the O-antigen. Complement and natural hemolysins are investigated. Antibody-producing cells are frozen in DMSO medium, held in liquid nitrogen and recovered to be used as positive controls in subsequent experiments.

Anderson, D. P., and B. S. Roberson.
1978. Immune response of rainbow trout to sheep red blood cells or an O-antigen from *Yersinia ruckerii*, a bacterial fish disease agent. Page 56 in Abstracts of the Annual Meeting of the American Society for Microbiology, Las Vegas, Nevada. 14-19 May 1978. (Abstract E82).

A high dose of sheep red blood cells induces an immune response in rainbow trout, whereas a low dose of *Yersinia ruckeri* O-antigen is sufficient. Splenomegaly corresponding to antigen dose is noted.

Anderson, D. P., and O. W. Dixon.
1979. Immunological memory in rainbow trout to fish disease bacterins administered by flush exposure. In Abstracts of the Annual Meeting of the American Society of Zoologists, Tampa, Florida. 27-30 December 1979. American Zoologist 19(3):931. (Abstract 401).

Rainbow trout immunized by a secondary exposure with an O-antigen extraction of *Yersinia ruckeri* develop only slightly higher immune responses as indicated by the numbers of splenic antibody-producing cells and humoral antibody titers compared to control fish given only a primary flush exposure.

Anderson, D. P., O. W. Dixon, and B. S. Roberson.
1979. Kinetics of the primary immune response in rainbow trout after flush exposure to *Yersinia ruckeri* O-antigen. Developmental and Comparative Immunology 3(4):739-744.

The immune response in trout given a single dose of bacterin by flush exposure shows that by the passive hemolytic plaque assay, antibody producing cells can first be detected on day 9 after immunization, with the highest numbers of cells occurring between days 14 and 21. No cells are observed after day 28.

## BACTERIAL DISEASES (CONTINUED)

Anderson, D. P., B. S. Roberson, and O. W. Dixon.
1979. Induction of antibody-producing cells in rainbow trout, *Salmo gairdneri* Richardson; by flush exposure. Journal of Fish Biology 15(3):317-322.

Splenic antibody-producing cells are demonstrated in rainbow trout immunized with *Yersinia ruckeri* or *Aeromonas salmonicida* O-antigen preparations by flush exposure.

Anderson, D. P., B. S. Roberson, and O. W. Dixon.
1979. Plaque-forming cells and humoral antibody in rainbow trout (*Salmo gairdneri*) induced by immersion in a *Yersinia ruckeri* O-antigen preparation. Journal of the Fisheries Research Board of Canada 36(6):636-639.

Plaque-forming cells from spleens of fish administered *Yersinia ruckeri* bacterins by immersion or injection are counted. Dipping the fish in salt solutions or an anesthetic before immersion in the bacterin suspension makes little or no difference in numbers of plaque-forming cells.

Anderson, D. P., B. S. Robertson [*sic*], and O. W. Dixon.
1979. Cellular immune response in rainbow trout *Salmo gairdneri* Richardson to *Yersinia ruckeri* O-antigen monitored by the passive haemolytic plaque assay test. Journal of Fish Diseases 2(2):169-178.

Dosage studies and methods of the passive hemolytic plaque assay and passive hemagglutination are described to detect the immune response in trout injected with *Yersinia ruckeri* O-antigen. Serological cross reactions with closely related bacteria are not observed.

Anderson, D. P., and O. W. Dixon.
1980. Immunological memory in rainbow trout to a fish disease bacterin administered by flush exposure. Pages 103-111 in M. J. Manning, editor. Phylogeny of immunological memory; proceedings of the International Symposium on Immunological Memory held at the American Society of Zoologists Meeting, Tampa, Florida. 28-30 December 1979. Elsevier/North-Holland Biomedical Press, Amsterdam.

The anamnestic response in rainbow trout is investigated by exposing the fish to *Yersinia ruckeri* O-antigen. No booster effect is observed. The antigen is T-independent in tests with nude and normal mice; therefore, a secondary response is not expected from this antigen.

## BACTERIAL DISEASES (CONTINUED)

Anderson, D. P., O. W. Dixon, and R. C. Simon.
1980. Fish biologics: vaccine standards for sport fisheries and commercial aquaculture. In S. S. Kalter and W. Hennessen, editors. Standardization of animals to improve biomedical research, production and control; proceedings of the 16th International Association of Biological Standardization Congress, San Antonio, Texas. 1979. Developments in Biological Standardization 45:157-162.

Standardization of different batches of bacterins for efficacy and potency by using the passive hemolytic plaque assay. Difficulties of methodology and differences in batches are discussed.

Anderson, D. P., and B. S. Roberson.
1980. Immunosuppression by cyclophosphamide and a corticosteroid in fish given a bacterin by flush exposure. Page 62 in Abstracts of the Annual Meeting of the American Society for Microbiology, Miami Beach, Florida. 11-16 May 1980. (Abstract E71).

The immune response in rainbow trout to a bacterin can be reduced by the injection of a corticosteroid. The injection of another immunosupressant, an alkylating agent, does not seem to reduce the numbers of antibody-producing cells at doses used.

Bullock, G. L.
1972. Studies on selected myxobacteria pathogenic for fishes and on bacterial gill disease in hatchery-reared salmonids. U.S. Fish and Wildlife Service, Technical Paper 60. 30 pages.

A cultural, biochemical, and serological comparison of myxobacteria isolated from tail rot, bacterial gill disease, and fin erosion in coldwater and warmwater cultured fishes. Studies on the etiology and induction of bacterial gill disease are also described.

Bullock, G. L., P. K. Chen, and H. M. Stuckey.
1972. Studies of motile aeromonads isolated from diseased warmwater and coldwater fishes. Page 21 in Abstracts of the Annual Meeting of the American Society for Microbiology, Philadelphia, Pennsylvania. 23-28 April 1972. (Abstract E123).

Describes and compares biochemical and serological characteristics of *Aeromonas hydrophila* isolates from diseased warmwater and coldwater fishes.

## BACTERIAL DISEASES (CONTINUED)

Bullock, G. L., and H. M. Stuckey.
1974. An improved procedure for diagnosing kidney disease in salmonid fishes. Fish Health News 3(3):17-18.

Describes an immunodiffusion procedure that uses infected tissues and specific antiserum for diagnosing kidney disease within 24 hours.

Bullock, G. L., H. M. Stuckey, and P. K. Chen.
1974. Corynebacterial kidney disease of salmonids: growth and serological studies on the causative bacterium. Applied Microbiology 28(5):811-814.

Procedures for growing the kidney disease bacterium on Mueller-Hinton medium with cysteine but no serum are described. Results of agglutination and precipitin tests show serological homogenicity of isolates.

Bullock, G. L., H. M. Stuckey, D. Collis, R. L. Herman, and G. Maestrone.
1974. In vitro and in vivo efficacy of potentiated sulfonamide in control of furunculosis in salmonids. Journal of the Fisheries Research Board of Canada 31(1):75-82.

Results from in vitro sensitivity tests and in vivo efficacy trials show potentiated sulfonamide Ro5-0037 effectively controls fish furunculosis at 50 mg per kg per day, one-fourth the level of sulfonamides.

Bullock, G. L., and S. F. Snieszko.
1975. Hagerman redmouth, a disease of salmonids caused by a member of the enterobacteriaceae. U.S. Fish and Wildlife Service, Fish Disease Leaflet 42. 5 pages.

A brief description of Hagerman redmouth disease that includes etiology, disease signs, diagnosis and detection, pathology, source of infection, host and geographic range, transmission and control procedures. An annotated bibliography is also included.

## BACTERIAL DISEASES (CONTINUED)

Bullock, G. L., and H. M. Stuckey.
1975. *Aeromonas salmonicida*: detection of asymptomatically infected trout. Progressive Fish-Culturist 37(4):237-239.

Injection of corticosteroid followed by exposure of trout to 19°C temperature is shown to cause overt furunculosis among asymptomatic *Aeromonas salmonicida* carriers. Direct inoculation from nonstressed carriers did not yield *A. salmonicida*.

Bullock, G. L., and H. M. Stuckey.
1975. Fluorescent antibody identification and detection of the *Corynebacterium* causing kidney disease of salmonids. Journal of the Fisheries Research Board of Canada 32(11):2224-2227.

Description of an indirect fluorescent antibody test for diagnosis and detection of the kidney disease bacterium.

Bullock, G. L., and H. M. Stuckey.
1975. Fluorescent antibody technique for rapid diagnosis of corynebacterial kidney disease. Fish Health News 4(2):2.

Describes a rapid and accurate serological procedure for diagnosing kidney disease using infected tissue.

Bullock, G. L., H. M. Stuckey, K. Wolf, and P. K. Chen.
1975. Bacterial kidney disease of salmonid fishes. U.S. Fish and Wildlife Service, Fish Disease Leaflet 41. 7 pages.

A brief description of bacterial kidney disease that includes etiology, disease signs, diagnosis and detection, pathology, source of infection, host and geographic range, transmission and control procedures. An annotated bibliography is also included.

Bullock, G. L., H. M. Stuckey, and R. L. Herman.
1976. Comparative suceptibility of Atlantic salmon (*Salmo salar*) to the enteric redmouth bacterium and *Aeromonas salmonicida*. Journal of Wildlife Diseases 12(3):376-379.

The authors show that *Yersinia ruckeri* is as pathogenic for Atlantic salmon as *Aeromonas salmonicida*. A 30 minute exposure of salmon to water-borne cells of *Y. ruckeri* killed half of the test salmon within 14 days.

## BACTERIAL DISEASES (CONTINUED)

Bullock, G. L.
1977. Vibriosis in fish. U.S. Fish and Wildlife Service, Fish Disease Leaflet 50. 11 pages.

A brief description of vibrio infections of fishes that includes etiology, disease signs, diagnosis and detection, pathology, source of infection, host and geographic range, transmission and control procedures. An annotated bibliography is also included.

Bullock, G. L., and H. M. Stuckey.
1977. Ultraviolet treatment of water for destruction of five gram-negative bacteria pathogenic to fishes. Journal of the Fisheries Research Board of Canada 34(8):1244-1249.

Filtration (25 nm) and 13,100-29,400 MWS/sg·cm ultraviolet dosage kills 99.90-100% of five gram-negative fish pathogens. Filtration (25 nm) and 13,000 MWS/sg·cm prevents transmission of furunculosis.

Bullock, G. L., H. M. Stuckey, and E. B. Shotts, Jr.
1977. Early records of North American and Australian outbreaks of enteric redmouth disease. Fish Health News 6(2):96-97.

Examination of cultures isolated from diseased fish from the eastern United States and Australia indicates enteric redmouth disease was present in a wider geographic area during the 1950s and 1960s than previously thought, and that the disease may not have originated in Idaho.

Bullock, G. L.
1978. Pasteurellosis of fishes. U.S. Fish and Wildlife Service, Fish Disease Leaflet 54. 7 pages.

A brief description of *Pasteurella* infections of fishes that include etiology, disease signs, diagnosis and detection, pathology, source of infection, host and geographic range, transmission and control procedures. An annotated bibliography is also included.

## BACTERIAL DISEASES (CONTINUED)

Bullock, G. L., and H. M. Stuckey.
1978. Direct and indirect fluorescent antibody tests for diagnosis of three bacterial diseases of fishes. Pages 44-46 in Proceedings of the Third Biennial Fish Health Section/AFS and Ninth Annual Midwest Fish Disease Workshops. Cover title: Proceedings of the Joint 3rd Biennial Fish Health Section and 9th Annual Midwest Fish Disease Workshops, Kansas City, Missouri. 15-18 August 1978.

The direct fluorescent antibody test is found to be as specific as the indirect procedure for identification of the bacteria causing kidney disease and furunculosis. The direct test requires only 7 minutes while the indirect test takes over an hour to complete.

Bullock, G. L., H. M. Stuckey, and D. Mulcahy.
1978. Corynebacterial kidney disease: egg transmission following iodophore disinfection. Fish Health News 7(2):51-52.

Results from experiments carried out simultaneously at two locations show kidney disease is egg transmitted and that 15 minute disinfection in 100 ppm organic iodine does not prevent transmission.

Bullock, G. L., and S. F. Snieszko.
1979. Enteric redmouth disease of salmonids. U.S. Fish and Wildlife Service, Fish Disease Leaflet 57. 7 pages.

An update of Fish Disease Leaflet 42. See page 65.

Bullock, G. L.
1980. Bacterial kidney disease of salmonid fishes caused by *Renibacterium salmoninarum*. U.S. Fish and Wildlife Service, Fish Disease Leaflet 60. 10 pages.

An update of Fish Disease Leaflet 41. See page 66.

Bullock, G. L., B. R. Griffin, and H. M. Stuckey.
1980. Detection of *Corynebacterium salmoninus* by direct fluorescent antibody test. Canadian Journal of Fisheries and Aquatic Sciences 37(4):719-721.

A description of a direct fluorescent antibody test that requires only 7-10 minutes to complete. The direct test is 100 to 1,000 times more sensitive than the gram stain in detecting kidney disease bacteria.

## BACTERIAL DISEASES (CONTINUED)

Chen, P. K., G. L. Bullock, H. M. Stuckey, and A. C. Bullock.
1974. Serological diagnosis of corynebacterial kidney disease of salmonids. Journal of the Fisheries Research Board of Canada 31(12):1939-1940.

Describes a rapid and accurate diagnosis of kidney disease using specific antiserum infected tissues in an immunodiffusion procedure.

Cipriano, R. C.
1980. An analysis of the extracellular growth products of *Aeromonas salmonicida* as virulence factors and potential immunogens. Page [27] *in* Proceedings of the Fifth Annual Eastern Fish Health Workshop, National Fish Health Research Laboratory, Leetown, West Virginia. 17-19 June 1980.

An extraction from Ph. D. Dissertation.

Cipriano, R. C.
1980. An analysis of the extracellular growth products of *Aeromonas salmonicida* as virulence factors and potential immunogens. Ph. D. Dissertation. Fordham University, New York. 147 pages.

The relation of extracellular materials produced by *Aeromonas salmonicida* to isolate virulence is analyzed and an assay system is developed to estimate the effectiveness of these materials as immunogens against furunculosis.

Griffin, B. R.
1979. An enzyme-linked antibody assay for detection of *Aeromonas salmonicida*. Fish Health News 8(3):i-ii.

Methods are described for the use of peroxidase labeled antibody in a direct assay for detection of as few as 500-1000 *Aeromonas salmonicida* cells in fecal samples from rainbow trout.

Håstein, T., and G. L. Bullock.
1976. An acute septicaemic disease of brown trout (*Salmo trutta*) and Atlantic salmon (*Salmo salar*) caused by a *Pasteurella*-like organism. Journal of Fish Biology 8(1)23-26.

Describes *Pasteurella*-like fish pathogens which later were shown to be nonpigmenting strains of *Aeromonas salmonicida*.

## BACTERIAL DISEASES (CONTINUED)

Herman, R. L.
1973. A review of the prevention and treatment of furunculosis. (Un expose sur la prophylaxie et la therapeutique de la furonculose). Pages 170-174 (text) and 196-199 (combined references of the panel) in W. A. Dill, editor. Symposium on the Major Communicable Fish Diseases in Europe and Their Control; panel reviews and relevant papers. Panel 6. Furunculosis of Salmonidae. EIFAC (European Inland Fisheries Advisory Commission) Technical Paper 17, Supplement 2. Food and Agriculture Organization of the United Nations, Rome.

Recommendations for the prevention and control of furunculosis.

Hosmer, M. J.
1980. Handling as a factor in mortality of trout with or without furunculosis. Progressive Fish-Culturist 42(3):157-159.

Crowding and handling for stocking causes higher mortality in diseased fish than just sampling. Healthy trout are able to tolerate more handling stress.

Mitchell, A. J., and J. A. Plumb.
1980. Toxicity and efficacy of Furanace on channel catfish *Ictalurus punctatus* (Rafinesque) infected experimentally with *Aeromonas hydrophila*. Journal of Fish Diseases 3(2):93-99.

Determines the toxicity of Furanace to channel catfish and the optimum time and concentration of Furanace required for effective treatment against *Aeromonas hydrophila*.

Meyer, F. P., and G. L. Bullock.
1973. *Edwardsiella tarda*, a new pathogen of channel catfish (*Ictalurus punctatus*). Applied Microbiology 25(1):155-156.

First description of an *Edwardsiella tarda* infection in fish. Characteristics of the organism, infectivity studies, and control procedures are described.

## BACTERIAL DISEASES (CONTINUED)

Shotts, E. B., and S. F. Snieszko.
1976. Selected bacterial fish diseases. Pages 143-151 in L. A. Page, editor. Wildlife Diseases; proceedings of the Third International Wildlife Disease Conference, Institute for Zoology and Hydrobiology, University of Munich, Munich. 1975. Plenum Press, New York.

Discusses diseases of fishes associated with *Aeromonas salmonicida, Aeromonas hydrophila, Vibrio anguillarum,* Enteric (Hagerman) redmouth bacterium, *Edwardsiella tarda, Flexibacter* (*Chondrococcus*) *columnaris, Corynebacterium* sp. and *Mycobacterium* sp., including host range, geographic range, clinical signs, diagnostic procedures and treatment.

Shotts, E. B., Jr., and G. L. Bullock.
1975. Bacterial diseases of fishes: diagnostic procedures for gram-negative pathogens. Journal of the Fisheries Research Board of Canada 32(8):1243-1247.

A diagnostic scheme employing 10 media, 4 reagents, and 5 specific antiserums is devised for identification of gram-negative pathogens of fishes.

Shotts, E. B., Jr., and G. L. Bullock.
1976. Rapid diagnostic approaches in the identification of gram-negative bacterial diseases of fish. In S. Egusa, editor. Recent advances in fish pathology; proceedings of an international seminar sponsored by Japan Research Group of Fish Pathology and Committee VI, 3 Nutrition and Production of Fish in the International Union of Nutrition Science, Tokyo, Japan. 11-12 August 1975. Fish Pathology 10(2):187-190.

Discusses various schemes available for rapid identification of gram-negative pathogens. Selection of moribund fish specimens and diagnostic approach are also discussed.

Snieszko, S. F.
1973. Furunculosis of Salmonidae. Panel 6 review. (Furonculose des Salmonides. Expose du groupe 6). Pages 157-162 (English), 163-169 (French), and 196-199 (combined references of the panel) in W. A. Dill, editor. Symposium on the Major Communicable Fish Diseases in Europe and Their Control; panel reviews and relevant papers. Panel 6. Furunculosis of Salmonidae. EIFAC (European Inland Fisheries Advisory Commission) Technical Paper 17, Supplement 2. Food and Agriculture Organization of the United Nations, Rome.

A review of furunculosis, the best known and most dangerous bacterial disease of Salmonidae. Includes nomenclature of the bacterium, occurrence, identification, etiology and control.

## BACTERIAL DISEASES (CONTINUED)

Snieszko, S. F., and G. L. Bullock.
1975. Fish furunculosis. U.S. Fish and Wildlife Service, Fish Disease Leaflet 43. 10 pages.

A brief description of furunculosis that includes etiology, disease signs, diagnosis and detection, pathology, source of infection, host and geographic range, transmission and control procedures. An annotated bibliography is also included.

Snieszko, S. F., and G. L. Bullock.
1976. Columnaris disease of fishes. U.S. Fish and Wildlife Service, Fish Disease Leaflet 45. 10 pages.

A brief description of columnaris disease that includes etiology, disease signs, diagnosis and detection, pathology, source of infection, host and geographic range, transmission and control procedures. An annotated bibliography is also included.

Snieszko, S. F., and G. L. Bullock.
1976. Diseases of freshwater fishes caused by bacteria of the genera *Aeromonas, Pseudomonas,* and *Vibrio*. U.S. Fish and Wildlife Service, Fish Disease Leaflet 40. 10 pages.

A brief description of motile *Aeromonas, Pseudomonas,* and *Vibrio* diseases of fishes that includes etiology, disease signs, diagnosis and detection, pathology, source of infection, host and geographic range, transmission and control procedures. An annotated bibliography is also included.

Snieszko, S. F.
1978. Bacterial diseases of fishes and their control. In R. A. Murchelano and A. Rosenfield, editors. Proceedings of the 2nd Annual Eastern Fish Health Workshop, Easton, Maryland. Cosponsored by the Oxford Laboratory of the Northeast Fisheries Center, National Marine Fisheries Service and the National Fish Health Research Laboratory of the U.S. Fish and Wildlife Service. 26-27 May 1977. Marine Fisheries Review 40(10):2-3. (Marine Fisheries Review Paper 1328).

A condensation of an oral presentation on bacterial diseases of fishes, directed to veterinarians.

## BACTERIAL DISEASES (CONTINUED)

Snieszko, S. F.
1978. Mycobacteriosis (tuberculosis) in fishes. Pet Age 8(1):23-25, 28.

Written to introduce tropical fish hobbyists and dealers to the problems of this disease in fishes. Discusses the etiology, signs and pathology, geographic range, and prevention and treatment.

Snieszko, S. F.
1978. Mycobacteriosis (tuberculosis) of fishes. U.S. Fish and Wildlife Service, Fish Disease Leaflet 55. 9 pages.

A brief description of mycobacteriosis of fishes that includes etiology, disease signs, diagnosis and detection, pathology, source of infection, host and geographic range, transmission and control procedures. An annotated bibliography is also included.

## FUNGAL DISEASES

Meyer, F. P., and J. A. Robinson.
1973. Branchiomycosis: a new fungal disease of North American fishes. Progressive Fish-Culturist 35(2):74-77.

Although a major problem in Europe, this fungal disease is new to largemouth bass and other fishes in North America. Control consists of destroying infected fish, then chemically sterilizing the ponds.

Neish, G. A., and G. C. Hughes.
1980. Fungal diseases of fishes. Book 6 in S. F. Snieszko and H. R. Axelrod, editors. Diseases of fishes. T. F. H. Publications, Inc., Neptune, New Jersey. 159 pages.

A review of the literature and discussion of fungal diseases of fishes from the viewpoint of mycologists having an interest in fish pathology. Includes discussions on morphology, taxonomy, systematics, pathology, epizootiology, prevention, and treatment of fungal diseases.

## PROTOZOAN DISEASES

Daniels, S. B., R. L. Herman, and C. N. Burke.
1976. Fine structure of an unidentified protozoon in the epithelium of rainbow trout exposed to water with *Myxosoma cerebralis*. Journal of Protozoology 23(3):402-410.

Microscopic examination of rainbow trout tissue reveals what appears to be a proliferative stage of a sporozoon. Its relationship to *Myxosoma cerebralis* remains unresolved.

Griffin, B. R., and E. M. Davis.
1978. *Myxosoma cerebralis*: detection of circulating antibodies in infected rainbow trout (*Salmo gairdneri*). Journal of the Fisheries Research Board of Canada 35(9):1186-1190.

Rainbow trout infected with *Myxosoma cerebralis* produce antibody against spore antigen. The antibody is detectable by the use of fluorescein labeled rabbit anti-trout IgM.

Hoffman, G. L., Sr., and G. L. Hoffman, Jr.
1972. Studies on the control of whirling disease (*Myxosoma cerebralis*). I. The effects of chemicals on spores *in vitro*, and of calcium oxide as a disinfectant in simulated ponds. Journal of Wildlife Diseases 8(1):49-53.

Results of the in vitro testing of calcium oxide, potassium hydroxide, chlorine, calcium hydroxide, ammonium chloride, sodium borate, potassium permanganate, Roccal, and copper sulfate on spores of *Myxosoma cerebralis*; and, the testing of calcium oxide under simulated pond conditions.

[Hoffman, G. L.]
1973. Protozoans. Pages 645-682 in R. J. Flynn. Parasites of laboratory animals. Iowa State University Press, Ames, Iowa.

The morphology, life cycle, pathologic effects, diagnosis and control of the most important flagellates, sporozoans and ciliates that parasitize fishes. There are 17 pages of tables that outline genus/species of parasite, geographic distribution, fish host, location in host, method of infection, and incidence in nature.

## PROTOZOAN DISEASES (CONTINUED)

Hoffman, G. L., and J. O'Grodnick.
1973. Pathogenicity and control of whirling disease (*Myxosoma cerebralis*) of salmonid fishes. Pages 33-34 in Program and abstracts of the 48th Annual Meeting of the American Society of Parasitologists, University of Toronto, Toronto, Canada. 25-29 June 1973. (Abstract 44).

Incidence and intensity of infection are related to the number of infective units in the experimental aquaria. Ultraviolet irradiation at 35,000 to 112,000 microwatt seconds/sq cm (MWS) is successfully used to disinfect contaminated water. Calcium oxide and chlorine are also used as disinfectants.

Hoffman, G. L.
1974. Disinfection of contaminated water by ultraviolet irradiation, with emphasis on whirling disease (*Myxosoma cerebralis*) and its effect on fish. Transactions of the American Fisheries Society 103(3):541-550.

Ultraviolet light at dosages of 35,000, 43,000, and 112,000 microwatt sec/cm$^2$ prevents infection of rainbow trout fry with water contaminated by *Myxosoma cerebralis*.

Hoffman, G. L., and C. J. Byrne.
1974. Fish age as related to susceptibility to *Myxosoma cerebralis*, cause of whirling disease. Progressive fish-Culturist 36(3):151.

Rainbow trout experimentally exposed to *Myxosoma cerebralis* when 4.5 months or older did not develop clinical signs of whirling disease.

Hoffman, G. L.
1975. Whirling disease (*Myxosoma cerebralis*): control with ultraviolet irradiation and effect on fish. Journal of Wildlife Diseases 11(4):505-507.

Ultraviolet irradiation at 18,000 microwatt seconds/cm$^2$ reduces *Myxosoma cerebralis* infection by 31-86%. Previously, the author found that 35,000 MWS/cm$^2$ reduces infectivity 100%.

## PROTOZOAN DISEASES (CONTINUED)

Hoffman, G. L., M. Landolt, J. E. Camper, D. W. Coats, J. L. Stookey, and J. D. Burek.
1975. A disease of freshwater fishes caused by *Tetrahymena corlissi* Thompson, 1955, and a key for identification of holotrich ciliates of freshwater fishes. Journal of Parasitology 61(2):217-223.

Epizootics of *Tetrahymena corlissi* in guppies (*Poecilia reticulatus*) are described. Histopathology revealed a marked invasiveness.

Hoffman, G. L.
1976. Protozoan disease of freshwater fishes: advances and needs. Pages 141-142 in L. A. Page, editor. Wildlife diseases; proceedings of the Third International Wildlife Disease Conference, Institute for Zoology and Hydrobiology, University of Munich, Munich. 1975. Plenum Press, New York.

A brief review of the most important protozoan diseases in the U. S. *Ichthyophthirius multifiliis* continues to be the number one worldwide parasite problem; better therapeutants are needed.

Hoffman, G. L.
1976. Whirling disease of trout. U.S. Fish and Wildlife Service, Fish Disease Leaflet 47. 10 pages.

The life cycle, diagnosis, and control of whirling disease caused by the protozoan, *Myxosoma cerebralis*. Includes an annotated bibliography.

Hoffman, G. L., and M. E. Markiw.
1977. Control of whirling disease (*Myxosoma cerebralis*): use of methylene blue staining as a possible indicator of effect of heat on spores. Journal of Fish Biology 10(2):181-183.

Nearly all spores heated at 90°C for 10 minutes and 70°C for 100 minutes became stained with 0.08% methylene blue giving presumptive evidence that they were killed.

Hoffman, G. L., and J. J. O'Grodnick.
1977. Control of whirling disease (*Myxosoma cerebralis*): effects of drying, and disinfection with hydrated lime or chlorine. Journal of Fish Biology 10(2):175-179.

Thorough air drying of contaminated mud kills the spores of *Myxosoma cerebralis*, but treatment of contaminated wet mud with hydrated lime apparently kills only the spores that are exposed. Chlorine is effective at 10 ppm in water.

Hoffman, G. L.
1978. Ciliates of freshwater fishes. Pages 583-632 in J. P. Kreier, editor. Parasitic protozoa. Volume II. Intestinal flagellates, histomonads, trichomonads, amoeba, opalinids, and ciliates. Academic Press, Inc., New York.

A world-wide review of freshwater fish ciliates.

Hoffman, G. L., and R. Walker.
1978. A new myxosporidan, *Dicauda atherinoidi* n. g., n. sp., of the minnow, *Notropis atherinoides* Rafinesque. Journal of Fish iseases 1(4):343-349.

A description of this unusual "tailed" myxosporidan which was found in emerald shiners in Michigan and New York.

Hoffman, G. L., S. L. Kazubski, A. J. Mitchell, and C. E. Smith.
1979. *Chilodonella hexasticha* (Kiernik, 1909) (Protozoa, Ciliata) from North American warmwater fish. Journal of Fish Diseases 2(2):153-157.

This newly recorded parasite in North America is slightly smaller than *Chilodonella cyprini*, has fewer "ciliary rows", and causes epizootics at warmer temperatures.

Hoffman, G. L., and A. J. Mitchell.
1980. Exotic *Mitraspora cyprini* and *Sphaerospora carassii* (Protozoa: Myxosporida) of goldfish now in the U. S. Page 82 in Program and abstracts of the 55th Annual Meeting of the American Society of Parasitologists, San Francisco, California. (Meeting actually held at University of California, Berkeley, California). 4-8 August 1980.

A description of these newly imported fish parasites. *Mitraspora cyprini* sometimes causes great losses of goldfish.

Landolt, M. L.
1973. *Myxosoma cerebralis*: isolation and concentration from fish skeletal elements--trypsin digestion method. Journal of the Fisheries Research Board of Canada 30(11):1713-1716.

Describes the use of trypsin to implement release and allow concentration and purification of spores of *Myxosoma cerebralis*. This method results in a sixfold increase in observable spores as compared to mechanical grinding.

## PROTOZOAN DISEASES (CONTINUED)

Leteux, F., and F. P. Meyer.
1972. Mixtures of malachite green and formalin for controlling *Icthyophthirius* and other protozoan parasites of fish. Progressive Fish-Culturist 34(1):21-26.

Results of laboratory and field trials of mixtures of malachite green and formalin for controlling protozoan parasites. Mixtures effectively control *Costia, Trichodina, Chilodonella, Scyphidia, Trichophrya,* and *Ichthyophthirius*.

Lunger, P. D., B. L. Rhoads, K. Wolf, and M. E. Markiw.
1975. Thin-section electron microscopy of mature *Myxosoma cerebralis* (Myxosporidea) spores. Journal of Parasitology 61(3):476-480.

A description of the fine structure of *Myxosoma cerebralis* spores as seen by transmission electron microscopy.

Markiw, M. E., and K. Wolf.
1974. *Myxosoma cerebralis*: comparative sensitivity of spore detection methods. Journal of the Fisheries Research Board of Canada 31(10):1597-1600.

The newly developed pepsin-trypsin-dextrose (PTD) method of spore release and concentration is compared with earlier detection procedures. The PTD method is far superior.

Markiw, M. E., and K. Wolf.
1974. *Myxosoma cerebralis*: isolation and concentration from fish skeletal elements--sequential enzymatic digestions and purification by differential centrifugation. Journal of the Fisheries Research Board of Canada 31(1):15-20.

A sequential procedure using pepsin and trypsin digestion followed by differential centrifugation through dextrose solution to release, concentrate, and purify spores and prespore stages of *Myxosoma cerebralis*. The procedure has immediate application in diagnostics and in research, e.g., in preparing myxosporidan antigen.

Markiw, M. E., and K. Wolf.
1977. *Myxosoma cerebralis*: results of indirect and direct fluorescent antibody testing. Fish Health News 6(4):191-193.

First report of comparisons of direct and indirect fluorescent antibody techniques (FAT) for serologic identification of *Myxosoma cerebralis*. The direct FAT is the more specific.

## PROTOZOAN DISEASES (CONTINUED)

Markiw, M. E., and K. Wolf.
1978. *Myxosoma cerebralis*: fluorescent antibody techniques for antigen recognition. Journal of the Fisheries Research Board of Canada 35(6):828-832.

Rabbit antisera is prepared against a mixture of spores and prespore stages of the parasite. Serum is then conjugated with fluorescein isothiocyanate and used in direct and indirect fluorescent antibody tests (FAT). Direct FAT is more specific and provides the first serologic method of identification. The method has application in diagnostics and in research on the life cycle of *Myxosoma cerebralis*.

Markiw, M. E., and K. Wolf.
1979. *Myxosoma cerebralis*: improving the sensitivity of the plankton centrifuge method of spore release and concentration. Fish Health News 8(2):ix-x.

When harvests from the plankton centrifuge method of spore release and concentration are trypsinized, the modification results in release of about 22% more spores. In addition, removal of tissue residues effects an eleven-fold increase in final spore concentration.

Markiw, M. E., and K. Wolf.
1980. *Myxosoma cerebralis*: trypsinization of plankton centrifuge harvests increases optical clarity and spore concentration. Canadian Journal of Fisheries and Aquatic Sciences 37(12):2225-2227.

Use of trypsin at 0.25% for 30 min at pH 7.2-7.5 releases an average of 22% additional spores and results in an eleven-fold increase in spore concentration. The procedure significantly enhances the sensitivity of spore detection by the plankton centrifuge method.

McCraren, J. P., M. L. Landolt, G. L. Hoffman, and F. P. Meyer.
1975. Variation in response of channel catfish to *Henneguya* sp. infections (Protozoa:Myxosporidea). Journal of Wildlife Diseases 11(1):2-7.

Histologic changes due to seven different disease manifestations are described.

## PROTOZOAN DISEASES (CONTINUED)

Meyer, F. P.
1974. Parasites of freshwater fishes; II, Protozoa 3. *Icthyophthirius multifiliis*. U.S. Fish and Wildlife Service, Fish Disease Leaflet 2. 5 pages.

A review of the etiology, life cycle, pathogenicity, and control of this dangerous parasite. Includes an annotated bibliography.

Nagel, M. L., and G. L. Hoffman.
1977. A new host for *Pleistophora ovariae* (Microsporida). Journal of Parasitology 63(1):160-162.

Occurrence of *Pleistophora ovariae* in the fathead minnow. Heretofore, this ovarian parasite has been found only in the golden shiner.

Pauley, G. B.
1974. Fish sporozoa: extraction of antigens from *Myxosoma cerebralis* spores which mimic tissue antigens of rainbow trout (*Salmo gairdneri*). Journal of the Fisheries Research Board of Canada 31(9):1481-1484.

First report of an antigenic preparation from the spore stage of any histozoic sporozoan parasite. The detection of asymptomatic carrier fish using the spore antigens is not successful because the antigens of *Myxosoma cerebralis* mimic those of trout.

Sawyer, T. K., G. L. Hoffman, J. G. Hnath, and J. F. Conrad.
1975. Infection of salmonid fish gills by aquatic amebas (Amoebida: Thecamoebidae). Pages 143-150 in W. E. Ribelin and G. Migaki, editors. The pathology of fishes. University of Wisconsin Press, Madison, Wisconsin.

A preliminary report describing the amoeba, *Thecamoeba hoffmani*, which causes epizootics in North America.

Wolf, K.
1974. Whirling disease research - a delineation of needs. Fish Health News 3(4):20-27.

Knowledge of whirling disease is assessed and areas of ignorance or research need are highlighted.

## PROTOZOAN DISEASES (CONTINUED)

Wolf, K., and M. E. Markiw.
1975. *Myxosoma cerebralis*: serological identification by indirect fluorescent antibody test. Fish Health News 4(4):8.

First report of the development of a serological method for the identification of *Myxosoma cerebralis*.

Wolf, K., M. E. Markiw, C. Gustafson, J. J. O'Grodnick, and T. Bender.
1975. *Myxosoma cerebralis*: comparative sensitivity of plankton centrifuge and sequential enzymatic digestion methods for recovery of spores. Fish Health News 4(3):9-10.

Results of quantitative comparisons of two methods of releasing and concentrating the spores of *Myxosoma cerebralis*, the cause of whirling disease.

Wolf, K., and M. E. Markiw.
1976. *Myxosoma cerebralis*: *in vitro* sporulation of the myxosporidan of salmonid whirling disease. Journal of Protozoology 23(3):425-427.

First report of an in vitro culture of a portion of the life cycle of a myxosporidan.

Wolf, K., and M. E. Markiw.
1979. *Myxosoma cerebralis*: a method for staining spores and other stages with silver nitrate. Journal of the Fisheries Research Board of Canada 36(1):88-89.

A comparison of eleven dyes for their ability to stain spores of *Myxosoma cerebralis* and to persist through plankton centrifugation or the pepsin-trypsin-dextrose methods of release and recovery. Silver nitrate was best.

## VIRAL DISEASES

Ahne, W., and K. Wolf.
1977. Spring viremia of carp. U.S. Fish and Wildlife Service, Fish Disease Leaflet 51. 11 pages.

A condensation of key features of the European rhabdovirus disease of the common carp. An annotated bibliography is also included.

## VIRAL DISEASES (CONTINUED)

Ahne, W., and K. Wolf.
1980. Viruserkrankungen der Fische. (Viral diseases of fishes). Pages 56-105 in H. -H. Reichenbach-Klinke. Krankheiten und Schädigungen der Fishche. (Diseases and injuries of fishes). 2d revised edition. Gustav Fischer Verlag, Stuttgart. (In German).

A comprehensive review of the nearly thirty viral diseases and viruses known from fishes. The work includes a section on diagnostic procedures. Key references and illustrations are provided.

Bullock, G. L., R. R. Rucker, D. Amend, K. Wolf, and H. M. Stuckey.
1976. Infectious pancreatic necrosis: transmission with iodine-treated and nontreated eggs of brook trout (*Salvelinus fontinalis*). Journal of the Fisheries Research Board of Canada 33(6):1197-1198.

Unequivocal evidence is presented for vertical transmission of infectious pancreatic necrosis virus and that 15 minute disinfection with organic iodine does not prevent transmission.

Darlington, R. W., R. Trafford, and K. Wolf.
1972. Fish rhabdoviruses: morphology and ultrastructure of North American salmonid isolates. Archiv für die gesamte Virusforschung 39(1-3):257-264.

First ultrastructural comparison of Oregon sockeye, infectious hematopoietic necrosis, and chinook salmon viruses. All proved to have the same size, shape, and fine structure.

McAllister, P. E., T. Nagabayashi, and K. Wolf.
1977. Viruses of eels with and without stomatopapillomas. In H. F. Kraybill, C. J. Dawe, J. C. Harshbarger, and R. G. Tardiff, editors. Aquatic pollutants and biologic effects, with emphasis on neoplasia; papers from the conference, New York Academy of Sciences, New York. 27-29 September 1976. Annals of the New York Academy of Sciences 298:233-244.

The status of five viral agents isolated from eels with and without stomatopapilloma is detailed. Some effects of environmental parameters on the incidence of the papilloma are reviewed.

## VIRAL DISEASES (CONTINUED)

McAllister, P. E., and R. R. Wagner.
1977. Virion RNA polymerases of two salmonid rhabdoviruses. Journal of Virology 22(3):839-843.

The optimal conditions for in vitro expression of the RNA-dependent polymerase associated with infectious hematopoietic necrosis (IHN) virus and viral hemorrhagic septicemia (VHS) virus are determined, and the transcription products are characterized.

McAllister, P. E.
1978. Viruses and virus diseases of salmonid fishes. In R. A. Murchelano and A. Rosenfield, editors. Proceedings of the 2nd Annual Eastern Fish Health Workshop, Easton, Maryland. Cosponsored by the Oxford Laboratory of the Northeast Fisheries Center, National Marine Fisheries Service and the National Fish Health Research Laboratory of the U.S. Fish and Wildlife Service. 26-27 May 1977. Marine Fisheries Review 40(10):21-23. (Marine Fisheries Review Paper 1338).

Characteristics of five salmonid viruses and their associated diseases. Those viral agents are infectious pancreatic necrosis virus, infectious hematopoietic necrosis virus, viral hemorrhagic septicemia virus, *Herpesvirus salmonis*, and the causative agent of viral erythrocytic necrosis in salmon.

McAllister, P. E.
1979. Fish viruses and viral infections. Pages 401-470 in H. Fraenkel-Conrat and R. R. Wagner, editors. Comprehensive Virology, Volume 14. Plenum Publishing Corporation, New York.

A comprehensive, systematic account of the biochemical, biophysical, and biological properties of fish viruses and virus-like agents as well as an overview of the diseases with which they are associated.

Mitchell, A. J., J. A. Plumb, and P. R. Bowser.
1978. Field and laboratory findings on a viral disease of golden shiners. Pages 34-36 in Proceedings of the Third Biennial Fish Health Section/AFS and Ninth Annual Midwest Fish Disease Workshops. Cover title: Proceedings of the Joint 3rd Biennial Fish Health Section and 9th Annual Midwest Fish Disease Workshops, Kansas City, Missouri. 15-18 August 1978.

Field observations and initial laboratory characterization of a virus found in golden shiners.

## VIRAL DISEASES (CONTINUED)

Nagabayashi, T., K. Wolf, D. P. Anderson, and M. C. Quimby.
1976. Characterization of EV-1 a new virus isolated from the eel (*Anguilla anguilla*). Page 254 in Abstracts of the Annual Meeting of the American Society for Microbiology, Atlantic City, New Jersey. 2-7 May 1976. (Abstract S 302).

A condensed characterization of the new EV-1 virus isolated from viscera of European eel with "cauliflower disease."

Nagabayashi, T., and K. Wolf.
1979. Characterization of EV-2, a virus isolated from European eels (*Anguilla anguilla*) with stomatopapilloma. Journal of Virology 30(1):358-364.

Formal characterization of a new virus from North American eels. Written for the virologist.

Plumb, J. A., O. L. Green, R. O. Smitherman, and G. B. Pardue.
1975. Channel catfish virus experiments with different strains of channel catfish. Transactions of the American Fisheries Society 104(1):140-143.

Evaluation of eight different strains of channel catfish fingerlings for their susceptibility to channel catfish virus. Mortality rates differ significantly between the strains, with hybrid strains having the lowest percentage of mortality.

Plumb, J. A., P. R. Bowser, J. M. Grizzle, and A. J. Mitchell.
1979. Fish viruses: a double-stranded RNA icosahedral virus from a North American cyprinid. Journal of the Fisheries Research Board of Canada 36(11):1390-1394.

The first description and characterization of the golden shiner virus. Its effect on the minnow industry is presently unknown.

Schultz, C. L., B. C. Lidgerding, and P. E. McAllister.
1978. Fish virus isolation: an evaluation of decontamination procedures. Page 59 in G. L. Buterbaugh, editor. Proceedings of the Second Annual Meeting of the Potomac Chapter of the American Fisheries Society, Cacapon State Park, West Virginia. 11-12 May 1978. (Abstract).

Membrane filtration and several antibiotic treatments effectively control bacterial and fungal contamination during virological examination of fish tissues and solids. Treatments using routine cell culture antibiotic concentrations are the most economical.

## VIRAL DISEASES (CONTINUED)

Wolf, K.
1972. Advances in fish virology: a review 1966-1971 Pages 305-331 in L. E. Mawdesley-Thomas, editor. Diseases of fish; proceedings of a symposium organized by the Fisheries Society of the British Isles and the Zoological Society of London, held at the Zoological Society of London. 20-21 May 1971. Symposia of the Zoological Society of London, Number 30. Academic Press, Inc., London.

A review of fish virology during the 5-year period. Updates a comprehensive chapter published earlier. (Wolf, K. 1966. The fish viruses. Advances in Virus Research 12:35-101.)

Wolf, K.
1972. Viral hemorrhagic septicemia (VHS). [U.S. Fish and Wildlife Service], Fish Disease Leaflet 6. 8 pages.

A condensation of key features of the virus and its disease. Written for the diagnostician, biologist, and hatcheryman.

Wolf, K., R. L. Herman, and C. P. Carlson.
1972. Fish viruses: histopathologic changes associated with experimental channel catfish virus disease. Journal of the Fisheries Research Board of Canada 29(2):149-150, plus 2 unnumbered pages of illustrations.

First description and illustrations of histopathologic changes produced by the channel catfish herpesvirus.

Wolf, K., and M. C. Quimby.
1972. Fish viruses: effects of buffers on plaquing eight agents under normal atmosphere. Page 208 in Abstracts of the Annual Meeting of the American Society for Microbiology, Philadelphia, Pennsylvania. 23-28 April 1972. (Abstract V140).

Abstract describes a single procedure whereby the known fish viruses can be plaqued.

Wolf, K.
1973. Herpesviruses of lower vertebrates. Pages 495-520 in A. S. Kaplan. editor. The herpesviruses. Academic Press, Inc., New York.

A comprehensive review of herpesviruses of reptiles, amphibians, and fishes. Thirteen agents and their effects on the host are covered.

## VIRAL DISEASES (CONTINUED)

Wolf, K.
1973. Piscine erythrocytic necrosis (PEN). Fish Health News 2(4):13-15.

Attention is called to a newly recognized viral infection of fish. The condition presents fresh research opportunities.

Wolf, K.
1973. Some facts, some opinions, and some misconceptions about channel catfish virus disease. Fish Health News 2(3):19-22.

The title is self-explanatory.

Wolf, K., and M. C. Quimby.
1973. Fish virology: procedures and preparation of materials for plaquing fish viruses in normal atmosphere. [U.S. Fish and Wildlife Service], Fish Disease Leaflet 35. 13 pages.

Stepwise description and illustrated procedures for plaquing fish viruses. Semi-technical in scope.

Wolf, K., and M. C. Quimby.
1973. Fish viruses: buffers and methods for plaquing eight agents under normal atmosphere. Applied Microbiology 25(4):659-664.

Technical report on the use of organic buffers for stabilizing pH of cell growth media and cell maintenance media, thereby providing a standardized procedure for plaque assay of the isolated fish viruses.

Wolf, K., M. C. Quimby, L. L. Pettijohn, and M. L. Landolt.
1973. Fish viruses: isolation and identification of infectious hematopoietic necrosis in eastern North America. Journal of the Fisheries Research Board of Canada 30(11):1625-1627.

First report of infectious hematopoietic necrosis in eastern North America. Complete documentation of a case history including identification by serum neutralization.

## VIRAL DISEASES (CONTINUED)

[Wolf, K.]
1974. Epitheliocystis and lymphocystis: a comparison of hypertrophied fish cells. Fish Health News 3(2):13-15.

Differences and similarities of the two fish diseases are described and illustrated.

Wolf, K.
1974. Rhabdovirus disease of northern pike fry. U.S. Fish and Wildlife Service, Fish Disease Leaflet 37. 4 pages.

Key features of this important viral disease of European pike are described. Written for the diagnostician, biologist, and hatcheryman.

Wolf, K., T. Nagabayashi, and M. C. Quimby.
1974. Atlantic salmon susceptible to IHN virus. Fish Health News 3(4):1.

Five-to-six month-old fingerling Atlantic salmon and brook trout were tested for susceptibility to infectious hematopoietic necrosis virus. Clinical signs of the disease appeared in salmon on the 6th day and in brook trout after 12 days. Reinforces the need for transporting only certified stocks of propagated fishes and eggs.

Wolf, K.
1975. Evaluation of the exposure of fish and wildlife to nuclear polyhedrosis and granulosis viruses. Pages 109-114 in M. Summers, R. Engler, L. A. Falcon, and P. V. Vail, editors. Baculoviruses for insect pest control: safety considerations; selected papers from the EPA-USDA Working Symposium on the Safety Considerations for the Use of Nuclear Polyhedrosis and Granulosis Viruses, Bethesda, Maryland. 15-18 April 1974. American Society of Microbiology, Washington, D. C.

Report on the use of lower vertebrate cell lines in safety testing of insect viruses for use in biological control of forest and agricultural pests.

Wolf, K., R. L. Herman, R. W. Darlington, and W. G. Taylor.
1975. Salmonid viruses: effects of *Herpesvirus salmonis* in rainbow trout fry. Fish Health News 4(3):8.

Describes in vivo and in vitro effects of *Herpesvirus salmonis*.

## VIRAL DISEASES (CONTINUED)

Wolf, K., T. Nagabayashi, and M. C. Quimby.
1975. *Herpesvirus salmonis*: tests of species susceptibility, suggestions for isolation, geographic distribution and control measures. Fish Health News 4(4):6-7.

Some characteristics of the new virus isolated from adult rainbow trout.

Wolf, K., T. Sano, and T. Kimura.
1975. Herpesvirus disease of salmonids. U.S. Fish and Wildlife Service, Fish Disease Leaflet 44. 8 pages.

A newly recognized viral agent is described. Features of natural and experimental infections in America and Japan are given.

Wolf, K., and W. G. Taylor.
1975. Salmonid viruses: a syncytium-forming agent from rainbow trout. Fish Health News 4(2):3.

First report of a new virus from a North American salmonid.

Wolf, K.
1976. Fish viral diseases in North America, 1971-75, and recent research of the Eastern Fish Disease Laboratory, U.S.A. In S. Egusa, editor. Recent advances in fish pathology; proceedings of an international seminar sponsored by Japan Research Group of Fish Pathology and Committee VI, 3 Nutrition and Production of Fish in the International Union of Nutrition Science, Tokyo, Japan. 11-12 August 1975. Fish Pathology 10(2):135-154.

A review of North American fish virology for the 5-year period, with emphasis on the virulent viruses, i.e., infectious pancreatic necrosis virus, infectious hematopoietic necrosis virus, channel catfish virus, and a newly isolated herpesvirus, lethal to young rainbow trout. There is also a brief summary of recent and current research at the Eastern Fish Disease Laboratory, now the National Fish Health Research Laboratory.

## VIRAL DISEASES (CONTINUED)

Wolf, K., R. W. Darlington, T. Nagabayashi, and M. C. Quimby.
1976. *Herpesvirus salmonis*: characterization of a new pathogen from rainbow trout (*Salmo gairdneri*). Page 235 in Abstracts of the Annual Meeting of the American Society for Microbiology, Atlantic City, New Jersey. 2-7 May 1976. (Abstract S 186).

A condensed characterization of the newly reported virus. Young rainbow trout are susceptible but Atlantic salmon, brown and brook trout are not.

Wolf, K., and M. C. Quimby.
1976. *Herpesvirus salmonis*: growth characteristics in vitro. Fish Health News 5(1):9.

The effects of the virus on fish cells in culture are described. Kinetics of a one-step growth curve are given.

Wolf, K., R. W. Darlington, W. G. Taylor, M. C. Quimby, and T. Nagabayashi.
1978. *Herpesvirus salmonis*: characterization of a new pathogen of rainbow trout. Journal of Virology 27(3):659-666.

Formal characterization of the virus for the virologist.

Wolf, K., and P. E. McAllister.
1978. Advances in fish virology and fish cell culture 1976-1978. Pages 37-41 in Proceedings of the Third Biennial Fish Health Section/AFS and Ninth Annual Midwest Fish Disease Workshops. Cover title: Proceedings of the Joint 3rd Biennial Fish Health Section and 9th Annual Midwest Fish Disease Workshops, Kansas City, Missouri. 15-18 August 1978.

Reviews the major advances in fish virology and cell culture for a 3-year period, highlighting those that have applications in health management of propagated freshwater, anadromous, and marine species.

Wolf, K.
1979. Comparative pathogenesis and virulence of poikilotherm vertebrate herpesviruses. Pages 183-200 in P. A. Bachmann, editor. Mechanisms of viral pathogenesis and virulence; proceedings of the 4th Munich Symposia on Microbiology, WHO Collaborating Centre for Collection and Evaluation of Data on Comparative Virology, Munich, Germany. 6-7 June 1979.

A comprehensive review of reptilian, amphibian, and fish herpesviruses and their respective infections and diseases.

## VIRAL DISEASES (CONTINUED)

Wolf, K. E., M. C. Quimby, C. P. Carlson, and W. J. Owens.
1979. Lymphocystis virus: infectivity of lesion preparations stored after lyophilization or simple desiccation. Journal of Fish Diseases 2(3):259-260.

Report of the successful reconstitution of viable lymphocystis virus 15 years after having been lyophilized.

Wolf, K.
1980. Fish virology 1980. Pages [34-35] in Proceedings of the Fourth Biennial Workshop of the Fish Health Section, American Fisheries Society and the Twenty-first Western Fish Disease Conference. Cover title: Proceedings of the Joint 4th Biennial Fish Health Section and Fish Disease Workshops, Seattle, Washington. 24-26 June 1980. (Abstract).

A condensed state-of-the-art report on fish virology, including the number of fish viruses that have been isolated and the extent of their characterization, the progress and expectations from fish vaccines, the rapid and convenient methods of virus identification, the number of existing fish cell lines, and the cell lines from important and propagated fishes that have been neglected.

Wolf, K.
1980. Virology of aquarium fishes, a review - 1980. Journal of Aquariculture 1(3):58-62.

Aquarium fish species play host to other viruses than lymphocystis and epitheliocystis. The numbers and types of viruses in aquarium fish are comparable to those in sport, resource and food fish, but remain to be discovered. Specific investigational approaches are outlined for investigating fish viruses.

## CELL AND TISSUE CULTURE

Lidgerding, B. C.
1979. Cell culture contaminants: a method for detection. Fish Health News 8(3):i.

A rapid and inexpensive method for detection of cell culture contaminants, including mycoplasma.

## CELL AND TISSUE CULTURE (CONTINUED)

Lidgerding, B. C., P. E. McAllister, and C. L. Schultz.
1979. Fish cell lines: bisbenzamide staining for the detection of contamination. In [Program and abstracts] of the Thirtieth Annual Meeting of the Tissue Culture Association, Seattle, Washington. 10-14 June 1979. In Vitro (Program Issue) 15(3):186. (Abstract 88).

Bisbenzamide staining is an inexpensive, rapid and reliable method for detecting mycoplasma contamination of fish cells.

Lidgerding, B. C., and C. L. Schultz.
1979. Fish cell lines: establishment of the first suspension culture. In [Program and abstracts] of the Thirtieth Annual Meeting of the Tissue Culture Association, Seattle, Washington. 10-14 June 1979. In Vitro (Program Issue) 15(3):216. (Abstract 222).

A report of the development and preliminary characterization of the first suspension culture of fish cells.

Wolf, K.
1973. Freshwater fishes. Pages 138-143 in P. F. Kruse, Jr. and M. K. Patterson, editors. Tissue culture: methods and applications. Section 2. Preparation of primary cultures. Academic Press, Inc., New York.

Description of methods for preparing primary cultures of fish cells.

Wolf, K., and M. C. Quimby.
1973. Towards a practical fail-safe system of managing poikilothermic vertebrate cell lines in culture. In Vitro 8(4):316-321.

Description of a system for managing cultures of fish and other animal cells, maintaining identity, purity, and freedom from contamination.

Wolf, K., and M. C. Quimby.
1976. Culture of leucocytes from teleost (bony) fishes. TCA (Tissue Culture Association) Manual 2(4):441-443.

Stepwise procedures are given for culturing fish leucocytes.

## CELL AND TISSUE CULTURE (CONTINUED)

Wolf, K., and M. C. Quimby.
1976. Primary monolayer culture of fish cells initiated from minced tissues. TCA (Tissue Culture Association) Manual 2(4):445-448.

Describes stepwise procedures for culturing fish cells from fragments of minced tissues.

Wolf, K., and M. C. Quimby.
1976. Primary monolayer culture of fish cells initiated from trypsinized tissues. TCA (Tissue Culture Association) Manual 2(4):453-456.

Describes stepwise procedures for culturing fish cells from trypsinized tissues.

Wolf, K., and M. C. Quimby.
1976. Procedures for subculturing fish cells and propagating fish cell lines. TCA (Tissue Culture Association) Manual 2(4):471-474.

Describes stepwise procedures for handling and subculturing fish cells and fish cell lines.

Wolf, K.
1977. Fish cell culture media. Pages 25-30 in M. Rechcigl, Jr., editor. CRC handbook series in nutrition and food. Section G: Diets, culture media, food supplements. Volume 4. Culture media for cells, organs and embryos. CRC (Chemical Rubber Company) Press, Inc., Cleveland, Ohio.

A review of the media used for the culture of cells from teleost or bony fishes.

Wolf, K.
1978. Ghoti cell culture--in perspective. TCA (Tissue Culture Association) Report 12(1):2-6.

An explanation of the development and applications of fish cell and tissue culture. Written for those who culture warm blooded, plant, or invertebrate animal cells.

## CELL AND TISSUE CULTURE (CONTINUED)

Wolf, K., and M. C. Quimby.
1978. Systematic management of animal cell lines. TCA (Tissue Culture Association) Manual 4(1):741-744.

A methodical system for growing, storing, and generally managing laboratory cell cultures for safety and purity.

Wolf, K.
1979. Cold-blooded vertebrate cell and tissue culture. Pages 466-477 in W. B. Jakoby and I. H. Paston, editors. Methods in enzymology. Volume 58. Cell culture. Academic Press, Inc., New York.

Procedures for initiating and growing lower vertebrate cell cultures are described for the biochemist.

Wolf, K.
1979. Laboratory management of cell cultures. Pages 116-119 in W. B. Jakoby and I. H. Paston, editors. Methods in enzymology. Volume 58. Cell culture. Academic Press, Inc., New York.

Procedures for managing cell lines are described for the biochemist.

Wolf, K., and J. A. Mann.
1979. Poikilotherm vertebrate cell lines and viruses: a current listing for fishes--1978. In [Program and abstracts] of the Thirtieth Annual Meeting of the Tissue Culture Association, Seattle, Washington. 10-14 June 1979. In Vitro (Program Issue) 15(3):223. (Abstract 257).

Highlights of the results of a world-wide survey of extant fish cell lines and fish viruses.

Wolf, K., and J. A. Mann.
1980. Poikilotherm vertebrate cell lines and viruses: a current listing for fishes. In Vitro 16(2):168-179.

Results of a world-wide survey of 61 extant fish cell lines and 32 viruses (those isolated and those known by electron microscopy). Cell lines are tabulated phylogenetically by family, genus, and species. Viruses are tabulated by nucleic acid type and major grouping (where known).

## OTHER DISEASES AND PARASITES

Bauer, O. N., and G. L. Hoffman.
1976. Helminth range extension by translocation of fish. Pages 163-172 in L. A. Page, editor. Wildlife diseases; proceedings of the Third International Wildlife Disease Conference, Institute for Zoology and Hydrobiology, University of Munich, Munich. 1975. Plenum Press, New York.

The migrations of fish helminths with their translocated fish hosts are listed and discussed. Translocation of dangerous fish parasites can be avoided by inspection of the fish, and the control and eradication of the parasites before the fish are shipped.

Healy, G. R., G. J. Jackson, J. R. Lichtenfels, G. L. Hoffman, and T. C. Cheng.
1976. Foodborne parasites. Pages 471-483 in M. L. Speck, editor. Compendium of methods for the microbiological examination of foods. American Public Health Association, Washington, D. C.

Methods for identifying foodborne parasites, including parasites of fishes. Includes a list of places where the food inspectors can ask for assistance.

Hendrickson, G. L., and G. L. Hoffman.
1979. Formation of the host cyst and associated pathology of *Ornithodiplostomum ptychocheilus* (Trematoda:Strigeoidea) in *Pimephales promelas*. Page 68 in Program and abstracts of the 54th Annual Meeting of the American Society of Parasitologists, Minneapolis, Minnesota. 29 July - 3 August 1979.

Discusses the development of the cyst surrounding the parasite. There is little host response to the parasite, but pressure damage to the brain is evident.

Herman, R. L., and M. Landolt.
1975. A testicular leiomyoma in a largemouth bass, *Micropterus salmoides*. Journal of Wildlife Diseases 11(1):128-129.

The first report of a leiomyoma in this species and this organ.

Hinton, D. E., R. T. Jones, and R. L. Herman.
1976. Glomerular mesangial fibrosis in hatchery-reared rainbow trout (*Salmo gairdneri*). Journal of the Fisheries Research Board of Canada 33(11):2551-2559.

Ultrastructural studies establish the diagnosis of glomerular mesangial fibrosis in the kidney tissues of rainbow trout.

## OTHER DISEASES AND PARASITES (CONTINUED)

[Hoffman, G. L.]
1973. Arthropods. Pages 754-768 in R. J. Flynn. Parasites of laboratory animals. Iowa State University Press, Ames, Iowa.

The morphology, life cycle, pathology, diagnosis and control of the most important crustaceans parasitizing fish. Includes *Argulus*, *Lernaea*, *Ergasilus*, *Achtheres*, and *Salmincola*.

Hoffman, G. L.
1973. The effect of certain parasites on North American freshwater fishes. Pages 1622-1627 in V. Sladecek, editor. Proceedings of the USSR 1971 Congress of the International Association of Theoretical and Applied Limnology. Volume 18, Part 3, Section XI. Parasitology. Publishing House "Nauka", Leningrad.

Twelve techniques are suggested for demonstrating the insidious and chronic effects of parasites on fishes. The more important parasites of freshwater fishes of North America are briefly discussed.

[Hoffman, G. L.]
1973. Helminths and leeches. Pages 683-750 in R. J. Flynn. Parasites of laboratory animals. Iowa State University Press, Ames, Iowa.

The morphology, life cycle, pathologic effects, diagnosis and control of the most important monogenetic trematodes, adult and larval digenetic trematodes, cestodes, nematodes, acanthocephalans and leeches that parasitize fishes. There are 34 pages of tables that outline genus/species of parasite, geographic distribution, fish host, location in host, method of infection and incidence in nature.

[Hoffman, G. L.]
1973. Mollusks. Pages 751-753 in R. J. Flynn. Parasites of laboratory animals. Iowa State University Press, Ames, Iowa.

A brief discussion of the larval mollusks that parasitize fishes. Includes a diagram of the life cycle of the freshwater clam.

Hoffman, G. L., E. V. Raikova, and W. G. Yoder.
1974. *Polypodium* sp. (Coelenterata) found in North American sturgeon. Journal of Parasitology 60(3):548-550.

The first North American record of *Polypodium* sp. in *Acipenser fulvescens*.

## OTHER DISEASES AND PARASITES (CONTINUED)

Hoffman, G. L.
1975. Lesions due to internal helminths of freshwater fishes. Pages 151-187 in W. E. Ribelin and G. Migaki, editors. The pathology of fishes. University of Wisconsin Press, Madison, Wisconsin.

The histopathology of lesions caused by trematodes, cestodes, nematodes, and acanthocephalans of freshwater fishes. Also includes a guide to the recognition of helminth types in tissue sections.

Hoffman, G. L.
1976. The Asian tapeworm, *Bothriocephalus gowkongensis*, in the United States, and research needs in fish parasitology. Pages 84-90 in Proceedings of the 1976 Fish Farming Conference and Annual Convention Catfish Farmers of Texas, Texas A & M University, College Station, Texas. 20-21 July 1976.

First report of the exotic pathogen in the United States. Species identification, life cycle, and control are discussed.

Hoffman, G. L.
1976. Parasites of freshwater fishes. IV. Miscellaneous. The anchor parasite (*Lernaea elegans*) and related species. U.S. Fish and Wildlife Service, Fish Disease Leaflet 46. 8 pages.

The life cycle, fishes affected, and methods for control of the anchor parasite and other related species. Includes an annotated bibliography.

Hoffman, G. L.
1977. *Argulus*, a branchiuran parasite of freshwater fishes. U.S. Fish and Wildlife Service, Fish Disease Leaflet 49. 9 pages.

The life cycle, host preference, pathogenesis, and control of *Argulus*. Includes an annotated bibliography.

Hoffman, G. L.
1977. Copepod parasites of freshwater fish: *Ergasilus*, *Achtheres*, and *Salmincola*. U.S. Fish and Wildlife Service, Fish Disease Leaflet 48. 10 pages.

Some species of these genera are pathogenic to fishes. A guide to identification, life cycle and methods for control are given. There is an annotated bibliography.

## OTHER DISEASES AND PARASITES (CONTINUED)

Hoffman, G. L.
1979. Helminthic parasite. Pages 40-58 in J. A. Plumb, editor. Principle diseases of farm-raised catfish. Southern Cooperative Series no. 225. Agricultural Experiment Station, Auburn University, Auburn, Alabama.

This chapter describes and illustrates the helminth parasites of channel catfish. It includes monogenetic and digenetic trematodes, cestodes and nematodes.

Hoffman, G. L.
1980. Asian tapeworm, *Bothriocephalus acheilognathi* Yamaguti, 1934, in North America. (Der asiatische Bandwurm, *Bothriocephalus archeilognathi* [*sic*] Yamaguti, 1934, in Nordamerika). In H. -H. Reichenbach-Klinke, editor. Beiträge zur Fischpathologie und -toxicologie (Contributions to fish pathology and fish toxicology). Gustav Fischer Verlag, Stuttgart. *Also published as* Fisch und Umwelt (Fish and Environment) 8:69-75.

The Asian tapeworm appears to be established in fish farms in North America where golden shiners, fathead minnows, and grass carp are raised. The life cycle in the U. S. is similar to that in Europe and Asia. The pathogenicity in small golden shiners is similar to that in small common carp in Europe. Surveillance and avoidance are the best control methods.

Hoffman, G. L.
1980. Asian tapeworm, 1979 update. Pages 34-35 in Research Workshop Summary of Papers, Catfish Farmers of America Annual Convention Trade Show, New Orleans, Louisiana. 6-8 March 1980.

Describes recent "import" of this dangerous parasite and outlines current control measures.

Hughes, S. G.
1980. Biomicroscopic and histologic observations of the eye pathologies resultant from riboflavin deficiency in the rainbow trout (*Salmo gairdneri*). Abstracts of papers presented at the 1980 Annual Meeting of the New York Chapter of the American Fisheries Society, Bergamo East, Marcy, New York. 1-2 February 1980. (Abstract).

Reports gross and histologic abnormalities in the lens and cornea of rainbow trout fed graded levels of riboflavin.

## OTHER DISEASES AND PARASITES (CONTINUED)

Hughes, S. G., G. L. Rumsey, and H. G. Ketola.
1980. Biomicroscopic and histologic pathology of the eye in riboflavin-deficient rainbow trout (*Salmo gairdneri*). Page 205 in Abstracts of the 72nd Annual Meeting of the American Society of Animal Science, Cornell University, Ithaca, New York. 27-30 July 1980. (Abstract 243).

Describes the developmental pathology in the cornea and lens of the eye of rainbow trout fed graded levels of riboflavin.

Ketola, H. G.
1978. Dietary zinc prevents cataract in trout. Federation Proceedings 37(3):584. (Abstract 1950).

Rainbow trout fed whitefish waste meal without zinc supplement had a 75% incidence of cataract. Addition of zinc prevented cataract and markedly improved growth.

Ketola, H. G.
1979. Influence of dietary zinc on cataracts in rainbow trout (*Salmo gairdneri*). Journal of Nutrition 109(6):965-969.

Results show that supplemental zinc in a diet containing white fish meal prevents cataracts. Emphasizes that other dietary factors can influence the efficacy of zinc. Provides a useful experimental approach to the elucidation of the mechanism of cataractogenesis.

Meyer, F. P.
1973. Anthelminthic treatment of channel catfish for tapeworm infections. Progressive Fish-Culturist 35(4):205-206.

A study of Di-N-butyl tin oxide added to the diet of channel catfish to control the tapeworm, *Corallobothrium fimbriatum*.

Meyer, F. P., and G. L. Hoffman.
1976. Parasites and diseases of warmwater fishes. U.S. Fish and Wildlife Service, Resource Publication 127. 20 pages. (Pamphlet).

A booklet intended mostly for fish farmers. The most important warmwater fish parasites and diseases are described, and possible control and therapy suggested.

## OTHER DISEASES AND PARASITES (CONTINUED)

Mitchell, A. J., and G. L. Hoffman.
1980. Important tapeworms of North American freshwater fishes. U.S. Fish and Wildlife Service, Fish Disease Leaflet 59. 18 pages.

Life cycles, hosts and range, distinguishing characteristics, transmission, clinical signs, pathology, control and treatment of important tapeworms of North America. Selected references are included.

Poston, H. A., D. L. Livingston, and D. G. Hedrick.
1973. Effect of method of introducing well water on the growth, body chemistry, and incidence of eye abnormalities of juvenile brown and rainbow trout. Progressive Fish-Culturist 35(4):187-190.

Effects of the manner of dispersing water on the incidence of eye deformities, growth, body chemistry, food conversion, and survival of trout.

Poston, H. A.
1977. The role of nutrition in preventing ocular lesions in salmonid fishes. Pages 83-86 in Proceedings of the 1977 Cornell Nutrition Conference for Feed Manufacturers, Syracuse, New York. 1-3 November 1977. Cornell University, Ithaca, New York.

Reports specific eye lesions caused by deficiencies of nutrients in trout and salmon diets.

Poston, H. A., R. C. Riis, G. L. Rumsey, and H. G. Ketola.
1977. The effect of supplemental dietary amino acids, minerals and vitamins on salmonids fed cataractogenic diets. Cornell Veterinarian 67(4):472-509.

Characterizes the development of ocular lesions in brook trout, lake trout, and rainbow trout fed diets deficient in specific nutrients.

Poston, H. A., R. C. Riis, G. L. Rumsey, and H. G. Ketola.
1977. Supplemental dietary methionine prevents cataracts in lake trout fed isolated soybean protein. Federation Proceedings 36(3):1098. (Abstract 4369).

Describes the gross and histologic development of a cataract in lake trout fed isolated soybean protein as the sole dietary protein.

## OTHER DISEASES AND PARASITES (CONTINUED)

Poston, H. A., R. C. Riis, G. L. Rumsey, and H. G. Ketola.
1978. Nutritionally induced cataracts in salmonids fed purified and practical diets. In R. A. Murchelano and A. Rosenfield, editors. Proceedings of the 2nd Annual Eastern Fish Health Workshop, Easton, Maryland. Cosponsored by the Oxford Laboratory of the Northeast Fisheries Center, National Marine Fisheries Service and the National Fish Health Research Laboratory of the U.S. Fish and Wildlife Service. 26-27 May 1977. Marine Fisheries Review 40(10):45-46. (Marine Fisheries Review Paper 1348).

The histologic development of cataracts and other ocular lesions in fish fed diets lacking certain vitamins, amino acids or minerals.

Poston, H. A., J. L. Wallace, R. C. Riis, and G. F. Combs, Jr.
1978. Cataractous and digestive protease responses of rainbow trout fed autoclaved isolated soybean protein and added methoinine [*sic*]. Federation Proceedings 37(3):839. (Abstract 3277).

Abstract discusses the effects of feeding autoclaved isolated soybean protein and supplemental methionine on enzyme activity, cataractogenesis and growth of trout.

Putz, R. E.
1972. Biological studies on the hemoflagellates *Cryptobia cataractae* and *Cryptobia salmositica*. U.S. Fish and Wildlife Service, Technical Paper 63. 25 pages.

Studies on the host range, vector relations, in vivo and in vitro culture, pathogenicity and cryogenic preservation of the hemoflagellates *Cryptobia cataractae* and *Cryptobia salmositica*.

Putz, R. E.
1972. *Cryptobia cataractae* sp. n. (Kinetoplastida:Cyptobiidae), a hemoflagellate of some cyprinid fishes of West Virginia. Proceedings of the Helminthological Society of Washington 39(1):18-22.

This species is described from the blood of cyprinid fishes. The vector is *Cystobranchus virginicus*. It is compared with other North American *Cryptobia* species.

## OTHER DISEASES AND PARASITES (CONTINUED)

Raikova, E. V., V. C. Suppes, and G. L. Hoffman.
1979. The parasitic coelenterate, *Polypodium hydriforme* Ussov, from the eggs of the American acipenseriform *Polyodon spathula*. Journal of Parasitology 65(5):804-810.

The American form of *Polypodium* from *Polyodon spathula* is compared to the typical European form, *Polypodium hydriforme*. Histology reveals that both forms belong to the same species, thus helping to relate the paddlefish to the sturgeons.

Riis, R. C., G. L. Rumsey, and C. Byrne.
1974. Cataract in trout. Pages 78-89 in Proceedings of the Third Fish Feed and Nutrition Workshop, Tunison Laboratory of Fish Nutrition, Cortland, New York. 24-25 September 1974.

A controlled study of young brown trout fed a commercial diet preparation, suspected of being cataractogenic. Results of histopathologic examination and the comparison of the suspect diet to a standard reference diet are given.

Snieszko, S. F.
1972. Nutritional fish diseases. Pages 403-437 in J. E. Halver, editor. Fish nutrition. Academic Press, Inc., New York.

A textbook article on diseases caused by deficiency, or excess, of vitamins and minerals as well as the effect of toxic substances resulting from improper handling and storage of fish food.

Snieszko, S. F.
1974. The effects of environmental stress on outbreaks of infectious diseases of fishes. Journal of Fish Biology 6(2):197-208.

A review of environmental stress factors in relation to increased susceptibility of fishes to infectious diseases. Stress conditions are temperature, eutrophication, sewage, metabolic products of fishes, industrial pollution, and pesticides.

Snieszko, S. F.
1974. Nutritional (dietary) gill disease and other less known gill diseases of freshwater fishes. [U.S. Fish and Wildlife Service], Fish Disease Leaflet 36. 2 pages.

A brief description of nutritional gill disease, "hemorrhagic" gill disease, and other gill diseases caused by protozoa, fungi, trematodes or other parasites. A short annotated bibliography is also included.

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An annotated listing of books and symposia published before 1978. Also includes a listing of journals and abstracting services that regularly include materials on diseases and parasites of fishes, and a listing of *Fish Disease Leaflets* through number 52 which are available from Technical Information Services, National Fisheries Center, Box 700, Kearneysville, West Virginia 25430.

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## MOVEMENTS, SEASONAL AND DEPTH DISTRIBUTION, ETC.

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